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OF THE

TORREY BOTANICAL CLUB

VOL. 48

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Errata

Page 3, line 12 from bottom, for "*Corcospora*" read "*Cercospora.*"
Page 37, line 13, for "*stenophylla*" read "*sphenophylla.*"
Page 58, line 14 from bottom, for "*angusta*" read "*angustum.*"
Page 69, line 13, for "*Calcites*" read "*Calycites.*"
Page 125, line 15 from bottom, for "PLATE 1" read "PLATE 2."
Page 126, line 9, for "—" read "2."
Page 247, line 5 from bottom, for "14" read "7."

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BULLETIN

OF THE

TORREY BOTANICAL CLUB

JANUARY, 1921

The relation of the health of the host and other factors to infection of Apium graveolens by Septoria Apii

H. E. THOMAS

Students of immunity and susceptibility have been slow to recognize any fundamental distinctions in the relations of host and parasite in the great group of organisms which cause disease in plants and animals and yet the concepts of saprophyte, semi-saprophyte, and obligate parasite have been current at least since the time of DeBary. Under the influence perhaps chiefly of Ehrlich's side chain theory of immunity, degrees of resistance have been regarded on the one hand as inversely parallel to the virulence of the attacking organism and on the other hand as directly parallel to the vigor of the host. In plant pathology this view has been particularly prominent in the literature of the facultative parasites. With the development of the science of immunity, the animal pathologist has gone so far as to regard the interactions of host and parasite as specific in each case. It is becoming increasingly apparent that the specificity in the relation of plant pathogens with their hosts must be reckoned with. The saprophytic fungus may be able to live on dead tissue from a wide range of plants, sometimes showing little preference for any one of them. The semisaprophyte may or may not be more limited in its food range on dead material and attacks from one to a considerable number of living plants with varying degrees of virulence and with variable results to the hosts. The obligate parasite is usually still more restricted in its host range and is much more closely

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adapted to the living host, having completely lost the ability to grow on dead tissue even that of its most common host. In the more highly specialized forms, the relation may become specific to such a degree that a comparatively slight change in either host or fungus will completely change the virulence of the parasite or the effect on the host. It is to be expected, after the long period of association necessary for the close adaptation of fungus to host, that both would be more or less similarly influenced by their environmental conditions. I shall present data to show that the infection of *Apium graveolens* by *Septoria Apii* is favored by conditions which accelerate the growth of the host.

HISTOCICAL INTRODUCTION

The late blight of celery was first reported in the United States in 1891 by Chester (4) and Humphrey (15). It had been described the previous year from Italy by Briosi and Cavara (3), probably the earliest record of the disease. Prillieux and Delacroix (29) reported it in France in 1894, and Sorauer (35) recorded its occurrence in Germany in severe form in 1896. It came to the notice of Salmon (34) in England about 1906. By 1897 the disease in America had spread to California and was reported by Rogers (31) as a serious pest in that state. An interesting suggestion as to the possible source of origin of the disease on cultivated celery comes from Pethybridge (26). This author found on wild celery a fungus which appeared to be identical with the form on the cultivated crop. He was able to transfer it to cultivated celery and produce typical infection. The wild form was growing in comparatively complete isolation and Pethybridge believes it very unlikely that the fungus could have spread from cultivated plants to this host. Hence he concludes that the wild form is probably the source of the pest. Dorogin (9) in Russia reports a new species of *Septoria* on celery, *S. Apii graveolentis*, in addition to the common species. The former is said to be more destructive than the latter. During the early and middle parts of the growing season no severe infection of celery is usually noted, although Salmon (34) found that serious damage was done throughout the growing season. Further study of the relation of this disease to temperature and other seasonal conditions is needed.

Duggar and Bailey (10), Clinton (5 p. 267), and Link and Gardner (19) have observed that both celery and celeriac are attacked by *Septoria* in storage. The first authors noted that over 50 per cent of the stored crop was made unsalable by this fungus in one instance.

No extensive observations seem to have been made on the degree of susceptibility of the commercial varieties of celery to the late blight. Salmon (4) tested several varieties and arranged them in the following series, the first being most susceptible: Solid White, Clark's Early Market, Superb Pink, Giant Red, Standard Bearer, celeriac. Howitt (4) noted that Golden Self Blanching was particularly susceptible. White (42) concluded in general that Golden Self Blanching was very susceptible to disease while Henderson's Easy Blanching was comparatively free from disease. On wild celery Pethybridge (26) found fewer and smaller spots produced by *Septoria*, which seemed never to kill the leaf entirely. He states that the fungus occurs on parsley though rarely in the British Isles. Cooke (7) and others have considered the forms on celery and parsley identical, although I have found no record of the transfer of the *Septoria* from one of these hosts to the others.

Some interesting observations were made by Kinney (16) on the relation of cultural practice to blights of celery. He found that the amount of disease was reduced by mulching with seaweed, soil, coarse manure or even blighted leaves. Plants grown in the shade of trees seemed to be less subject to "blight." Unfortunately the author did not distinguish between *Septoria* and *Corcospora* blight. Zobel (43) believes that reduction of the amount of manure in the trenches and top dressing the soil with kainit greatly reduced the amount of *Septoria* in England.

Attempts to avoid or control the late blight, while not uniformly successful, are in practical agreement in the essentials. Rogers (31), Salmon (34), Howitt (14), Coons and Levin (8), and Krout (18) obtained practical control of the disease with Bordeaux mixture.

MATERIALS AND METHODS

I have attacked the problem of the relation of health, age and other conditions to susceptibility by means of inoculation experi-

ments with celery in the greenhouse, where the health of the host was altered by various experimentally controlled conditions. Each set of plants was accompanied by control plants and no attempt has been made to compare in any detail plants inoculated at different dates or plants which for any reason cannot be referred to the same control plants. Some experiments with hosts other than celery were made to show the host range of the *Septoria* and will be taken up in detail later in the paper. The plants were grown in pots usually in garden oil which was screened and mixed to obtain uniformity. Inoculations were made by atomizing with a suspension of spores taken from infected leaves. The plants of a series were placed in a group, alternating test and control plants, and were atomized from above and from the sides to obtain maximum dosage. The spore suspension was diluted in one case 1 to 10 and in another 1 to 20 without any marked decrease in the amount of infection produced. The counts in these cases were not high, however. The inoculation chamber was a rectangular box constructed from window sashes and lined with burlap which was saturated with water at the time of inoculation. The plants were usually kept in the inoculation chamber about forty-eight hours. Since *Septoria* spreads only slightly in the dry atmosphere of the greenhouse and since celery is little affected by other pests under these conditions, this is a particularly convenient form for study. The difficulty of accurately measuring the amount of infection was obvious here as in all infection experiments. However, when only plants of equal age and approximately equal size are compared it seems accurate to count the total number of spots per leaf or per plant. This method is not satisfactory in older plants in variety tests since there is considerable difference in the size of mature plants of different varieties. The methods employed for the computation of leaf area are too unwieldy for use with plants in any considerable numbers.

NAME OF THE PARASITE

The specific name of the *Septoria* under consideration is involved in one of the more or less hopeless name tangles which serve so frequently to confuse the minds of botanical workers. Chester (4) in making one of the earliest reports (1891) on the

fungus in America expresses uncertainty as to the identity of the species but includes a description of the fungus and states that if it is a new species it "might be named *Septoria Apii*." Rostrup (33) in Denmark (1893) published the same name apparently independently. Briosi and Cavara (3) published their variety of *Septoria Petroselini* in 1890 (appeared 1891). Klebahn (17) reviewed the situation at some length, examined the exsiccati and decided in favor of the name *S. Apii* Rostr. Quanjer and Slagter in Holland (30) and Coons (8) in this country have treated the fungus under the same name. It will be noted later that the fungus I have studied, so far as it has been tested, does not produce infection on parsley either in the greenhouse or in the field. It has already been pointed out that no report of cross inoculations has been found in the literature, although a number of authors have taken it for granted that the form on parsley and the one on celery are identical. Therefore, whether or not it be granted that the failure to cross infect between these closely related hosts be considered ground for making a specific distinction, I shall continue to use the name *S. Apii* Rostr., especially since it is already quite widely distributed in the literature. The question of nomenclature may well be left till our knowledge of the life history of the fungus is completed by the discovery of an ascigerous stage.

CHARACTER OF THE SPOT

The spots on the celery leaves when mature are rounded, brownish, and usually quite distinct in outline. In severe cases, as the leaves become older and the spots more numerous, the tissue between the spots breaks down and the entire leaf may wither. Pycnidia may, however, appear while the spot is still quite or entirely green. In this respect *S. Apii* is widely removed from those species in which the pycnidia ripen after the development of a well-marked discolored area. The mycelium of the fungus is at first intercellular and may spread at least from one to two millimeters through the tissue before the cells of the host break down. This stage is reached after from ten to fifteen days, depending on the temperature, the condition of the host, and perhaps other factors. The collapse of the mesophyll and palisade cells is quite complete and leaves little more than the epidermal

layers with fragments of leaf cells mingled with the mycelium of the fungus making up the spot. Pycnidia begin to form before the tissue breaks down, in fact it is not uncommon, as has been noted, to see, with the hand lens, mature pycnidia with ostioles on tissue which is still green and in which no shrinkage can be detected. The pycnidium originates usually if not always in an intercellular space, frequently in the substomatal cavity and as it increases in size the adjacent cells are broken down and successively become replaced by the heavy thick-walled hyphal elements. Occasionally a portion of a cell may remain intact until its lumen is tightly packed with the mycelium. The origin of the pycnidium is not necessarily always subepidermal but may be at any point in the mesophyll or palisade tissue. On the petiole, however, the pycnidia seem to be restricted to the outer layers, none having been observed deeper than the third or fourth cell layer. When the leaf tissue collapses the pycnidia become more conspicuous, projecting above the general level of the spot. From the sharpness of the margin, which appears macroscopically between the spot and the surrounding tissue, it might be concluded that the margin of the mycelial growth is coincident or nearly so with the margin of the spot. In sections, however, the mycelium is found at a distance of several cell diameters in advance of the breaking down of the tissue. It has been noted further that pycnidia are visible with low magnification in the green margin surrounding the spot. As the spot ages, there is a reduction in the green color of the tissue immediately surrounding it. Strangely enough, however, when the leaf yellows from age this partially yellowed region retains its color longer than any other portion of the leaf. Whether or not the green is intensified in this area as it diminishes elsewhere, I am not able to say from my observations. However, it is plain that in some way the fungus has caused the prolongation of the life of the cells in this region beyond that of the cells of the remainder of the leaf. This is further evidenced by the fact that on petioles which are wilted gradually, the loss of both chlorophyll and water is inhibited in the vicinity of infected spots, especially the smaller spots (which do not lose any considerable amount of water through the dead tissue). This condition was especially marked in a plant in the field which had its lower roots cut by mice and was wilting slowly.

On the seed the fungus does not produce a definite spot. The pycnidium is found imbedded in the pericarp with only a small spreading of the mycelium into adjacent tissue. In the sections studied, the mycelium did not penetrate to the embryo. That this may occur, however, seems reasonably to be expected and it would probably result in most cases in inhibiting germination of the seed.

CULTURAL CHARACTERS OF THE FUNGUS

The fungus grows readily although slowly on a variety of media in pure culture. On starch,* beef peptone, and celery decoction agars the fungus produced somewhat greater radial growth at comparatively low temperatures (13°–19° C.) than at a temperature ranging from 22° to 27° C. On starch agar, which was the most satisfactory medium tested, a colony 15–18 mm. in diameter was produced in four weeks with mature pycnidia and considerable superficial fine white mycelium. As the culture ages the mycelium becomes coarser and darker until finally the surface of the medium is covered with a dense black weft. On the agar prepared from a decoction of celery leaves, the growth is similar to that described above but less vigorous. In marked contrast is the colony produced on ordinary beef peptone agar. The mycelium is dark and coarse from the beginning, radial growth is small and the result is an irregularly pulvinate colony very densely compacted. A somewhat similar growth was obtained on steamed coconut, bean stems, and petioles of celery and beet. When celery leaves were mixed with garden soil and steamed, no growth of the fungus could be obtained. Clean white sand was substituted for the soil and a good vigorous growth followed even spreading into the sand adjacent to the celery tissue.

SPECIALIZATION OF SEPTORIA APII AS TO HOSTS

It has been accepted by a number of pathologists in Europe, America and elsewhere that the *Septoria* of celery is transferable to parsley and *vice versa*, although I have found no record of inoculations to settle this question definitely. I have attempted to determne to what extent the celery fungus has become special-

* Czapek's formula, with 10 gm. corn starch substituted for the sugar.

ized in its choice of a host by inoculating plants from the following groups: (*a*) plants of the family Umbelliferae, including varieties of celery; (*b*) miscellaneous plants, nearly all of which are known to be hosts of *Septoria*. The varieties of celery were tested both in the greenhouse and in the field. TABLE I shows the relative

TABLE I

RELATIVE SUSCEPTIBILITY OF VARIETIES OF CELERY UNDER GREENHOUSE CONDITIONS*

Variety	No. of plants	Average number of spots per plant	
		First inoculation	Second inoculation
White Plume	12	15.7	170.5
New Rose	10	8.4	167.0
Golden Self Blanching	12	15.2	124.1
Giant Pascal	12	4.0	103.0
Winter Queen	12	2.4	51.4
Golden Half Dwarf	12	6.1	43.7
Celeriac	11	3.2	23.0

susceptibility of six of the common varieties of celery and of celeriac under greenhouse conditions. The plants grown in the greenhouse were six to eight inches high at the time of the first inoculation (June 26 and June 30), and were quite uniform in size (except the variety, Giant Pascal, which was somewhat larger). The plants were not in a vigorous growing condition judging from the yellowing of outer leaves and the slow rate of growth. It will be noted that the first inoculation produced comparatively low counts. The plants were inoculated again without repotting on August 27 and August 29 when conditions were more favorable for infection. The data as far as they go suggest that there is some consistent difference in varietal susceptibility, although no variety shows any pronounced resistance. The white varieties, Golden Self Blanching and White Plume, show especial susceptibility. In the field the variety test included the varieties Boston Market and Henderson's Easy Blanching, in addition to the varieties used in the greenhouse. The estimation of damage done by the fungus was much less simple in the field than in the

* A number of these plants were found to be infested by nematodes. However, among the lowest counts resulting from the infestation were those of three plants of the variety, White Plume, which stands highest in the total counts. Hence it does not seem that the presence of the nematodes materially affects the position of the varieties as presented here.

greenhouse. The season was favorable for vigorous development of the fungus and as a result the spots soon ran together and caused the collapse of the entire leaf. Consequently the method of counting spots could not be used. The total weight of celery produced would be inaccurate as an index of the severity of the attack, since the varieties differ normally in the weight of the mature plant. However, certain general conclusions can be drawn from the gross appearance of the plants at the end of the season. The plants were inoculated by atomizing a single plant of each variety on August 5. On October 29, at the time of digging, the variety Golden Self Blanching had been so severely damaged that only a few living leaves remained. During the latter part of the season while the plants were blanching, a soft rot was associated with the late blight on all of the varieties. This was especially severe on the Golden Self Blanching and seemed to follow in areas of dead tissue killed by the *Septoria*, especially on old leaves. The unusually wet period at that time would have favored the development of the various saprophytes which are present under such conditions. Of the varities other than Golden Self Blanching, there was no easily recognizable difference in susceptibility. Easy Blanching (Henderson's) seemed to withstand the blight and subsequent rot slightly better than the other varieties. White Plume, a self blanching form, was not noticeably poorer than the green varieties. An accurate method of estimating the amount of infection would probably have shown differences which could not be noted with certainty from the general appearance.

Infection tests on various Umbelliferae and a considerable number of miscellaneous plants have shown that the species of *Septoria* under consideration here is very limited in its host range, if not entirely restricted to the single species, *Apium graveolens*, and its variety *rapaceum*. Parsley (*Petroselinum sativum*) has been inoculated repeatedly in the greenhouse under controlled conditions but no sign of infection has been produced. The tests included the plain leaved parsley (two varieties), the curly-leaved type and the Hamburg or turnip-rooted parsley. The plain parsley was grown in the field in a row adjacent to heavily infected celery but infection was never found on any of the

plants. Whether there are other strains of the fungus which infect both celery and parsley is a question of interest, both theoretically and practically, and should receive further attention. The various other hosts tested were grown in pots in the greenhouse and inoculated with celery plants in every case to check on the conditions for infection. The following plants were tested:

UMBELLIFERAE

Anethum graveolens L., dill
Anthriscus cerefolium (L) Hoffm., chervil (beaked parsley)
Carum Carvi L., caraway
Coriandrum sativum L., coriander
Cryptotaenia canadensis (L.) DC., hone wort
Daucus Carota L., carrot (both wild and cultivated)
Foeniculum officinale All., fennel
Osmorhiza sp., sweet cicely
Pastinaca sativa L., parsnip
Petroselinum sativum Hoffm., parsley (plain leaf, curly leaf, and Hamburg varieties)
Silaus Besseri

MISCELLANEOUS

Antirrhinum majus L., snapdragon
Beta vulgaris L., beet (sugar and garden varieties)
Lactuca sativa L., lettuce
Lobelia sp.
Lycopersicum esculentum Mill., tomato
Nicotiana Tabacum L., tobacco
Pisum sativum L., pea

None of the plants listed here developed any sign of infection. From these data it must be concluded that the *Septoria* of celery has reached a comparatively high degree of specialization as to its hosts. These results agree essentially with those of Beach (1), working with a considerable number of other species of the genus *Septoria*.

EFFECT OF FERTILIZERS UPON INFECTION

Realizing that the terms health, vigor, and vitality are vague and difficult of definition in plants as in animals, I have attempted

to modify these conditions in celery plants by various methods of feeding and handling to determine the influence of such treatment upon the interaction of host and parasite. The direct effect upon the plants has been visible in some cases in the increase or decrease in growth, the putting out of new leaves or the dropping of old leaves and in the turgidity of the tissues. In other instances the reaction to the treatment was not so directly evidenced. The difficulty in obtaining properly controlled results is obvious, but I have made a number of experiments to test the amount and character of the infection produced by inoculating plants in different conditions of health more or less artificially induced.

One of the first striking results noted was that which was produced by treating pot bound plants with sodium nitrate in solution. Five plants in four-inch pots of garden soil received each 1 gram of sodium nitrate in 100 c.c. of water. In this and in the succeeding experiments, the control plants received an amount of water equivalent to that used in the solution with the nutrient. The plants were inoculated at the time the nitrate solution was added.

TABLE II

INCREASE IN INFECTION PRODUCED BY TREATING POT BOUND PLANTS WITH SODIUM NITRATE SOLUTION

Plant No.	1	2	3	4	5	Average No. leaves	Average No. spots per leaf
Sodium nitrate.....	348	185	177	189	238	10.6	24.3
Control.....	234	97	11	43	38	8.0	10.6

TABLE II shows the very marked increase in infection obtained upon the plants which received the fertilizer. This difference is unusually marked due to the fact that the plants were badly pot bound and growth had been markedly checked.

With the garden soil used, the addition of calcium sulfate in the dry form, as it has been used in agricultural practice, produced a small decrease in infection. This series was prepared by mixing about five grams of calcium sulfate with the soil of each pot at the time of repotting. Twenty-four days later these plants were inoculated with controls. After the records were taken these plants were kept upon the greenhouse bench in compara-

tively dry atmosphere until the infection had largely been thrown off. They were again inoculated July 10, nine weeks after the first inoculation. The results of both inoculations are shown in TABLE III. The lower counts on the second inoculation may be

TABLE III

DECREASE IN INFECTION UPON PLANTS TREATED WITH CALCIUM SULFATE

Plant No.	First inoculation						Second inoculation						Spots per plant, first inoculation	Spots per plant, second inoculation
	1	2	3	4	5	6	1	2	3	4	5	6		
$CaSO_4$.....	387	281	266	301	271	505	87	28	56	14	80	79	335.1	57.3
Controls.....	623	368	495	350	342	382	94	113	172	99	80	36	426.6	99.0

explained partly by the fact that the plants had by this time become pot bound and partly by the influence of seasonal conditions, for during the warm weather of midsummer, no high infection counts were obtained on any plants in the greenhouse regardless of their condition. It will be seen that there is a consistent decrease in the counts on the treated plants from both inoculations. The plants were not appreciably altered in appearance by this application.

TABLE IV

EFFECT UPON INFECTION OF FEEDING WITH VARIOUS FERTILIZERS AND IN ONE CASE TOP DRESSING WITH LIME

Plant No.	1	2	3	4	5	6	7	8	9	10	Average No. leaves	Average No. spots per leaf
Controls.....	246	607	168	143.	614	799	460	1,139	589	196	6.0	82.6
KH_2PO_4.....	506	412	778	318	385	925	1,117	592	144	362	6.5	85.2
$Ca(NO_3)_2$ and KNO_3	412	429	723	286	779	982	645	748	260	376	6.3	89.5
Complete nutrient solution.....	559	662	1,237	276	1,009	1,242	543	403	247	429	6.9	95.7
Sheep manure.....	494	772	461	576	522						5.0	113.0
Hydrated lime ($CaCO_3$).....	103	259	518	394	430						5.6	60.8

With these results in mind further tests were planned to include complete fertilizers as well as their components. A nutrient solution was prepared according to a Pfeffer formula (27): 4 gm. calcium nitrate, 1 gm. potassium nitrate, 1 gm. magnesium sulfate, 1 gm. potassium acid phosphate, 0.5 gm potassium chloride, trace of ferric chloride, were dissolved in 3 liters of water.

Ten plants received each 100 c.c. of this solution. Two other sets of ten plants were treated respectively with nitrates and phosphates equivalent to the amounts fed to the first set in the complete nutrient solution. Five plants received 5 gm. each of hydrated lime on the surface of the soil and the soil of five others was top dressed with sheep manure. All of these plants were inoculated together with controls immediately after the addition of the fertilizers. The infection counts from them are shown in TABLE IV. All of the plants seemed vigorous in their gross appearance except those treated with lime. In this case the roots in the upper inch or so of the soil were discolored and some appeared to be killed outright. The leaves appeared somewhat less turgid and vigorous than those of the other series.

The small margin of difference between the controls and treated plants, especially in the case of the phosphate, makes the results appear doubtful. It must be borne in mind, however, that the concentration of the solutions was that recommended for water cultures and did not result in marked increase of growth in the treated series. When it is considered that each plant in the nitrates series receives only 0.166 gm. of the salt, it will be seen that striking results cannot be expected except with the lime and manure whch were applied in considerable quantity. However, the results are in accord with those of the other experiments reported here. Whether or not the increase in new growth under field conditions would enable fertilized plants to increase the total yield in spite of increased infection is of course not shown by these experiments.

In watching the plants from day to day it seemed that not only was there an increase in the number of spots on plants treated with fertilizer but there was also a tendency toward the formation of larger spots and more rapid breaking down of the tissue between the spots. In the field, where conditions were more favorable for the growth of the host than could be supplied in pots in the greenhouse, a count of our nineteen hundred spots was obtained from a single leaf (Easy Blanching) and, as will be pointed out later, the older leaves regularly withered entirely from the coalescing of the spots. It is true that the field conditions of the season in question were also more favorable for the develop-

ment of the fungus than the greenhouse conditions. However, the fact that a single leaf in the field bears more infections than any count obtained on an entire plant in the greenhouse is noteworthy. To obtain some statistical evidence of the relation of the fertilizer treatments to the size of the spot, two sets of five plants each in three-inch pots were treated respectively with 2 grams of hydrated lime per plant as top dressing, and 1 gram of sodium nitrate per plant in solution. The effect upon both the number and extent of infection areas is shown in TABLE V.

The nitrate plants average 284 spots per plant as opposed to 120 spots per plant on the limed plants and, what is perhaps even more significant, the difference in the size of the spots is proportional, the spots of the nitrate plants averaging 2.64 mm. in diameter while those of the limed plants average only 1.06 mm. The ratios are as 1: 2.36 and 1: 2.54, respectively. These data indicate that the degree of susceptibility is dependent upon the interchanges between the host cells and fungus hyphae rather than upon the ability or lack of ability of the fungus to penetrate the host.

In a further attempt to produce varying conditions of health in the experimental plants, sets of five plants each were watered with 50 c.c. of each of the following solutions: 2 per cent sodium chloride, 1 per cent magnesium chloride, 1 per cent barium chloride, 0.1 per cent ferric chloride, 0.1 per cent zinc chloride. These were inoculated with controls as in the preceding experiments. The results are not sufficiently uniform to be considered significant. The health and growth of the plants were not perceptibly altered and the amount of infection was fluctuating. The plants treated with magnesium, iron and zinc were somewhat lower in total counts than the controls, while the barium series gave the highest counts of all. It is to be remembered that our lack of knowedge in regard to the behavior of these substances in relation to the soil and to the selective absorption phenomena exhibited by the roots of plants would make any but the most striking results extremely difficult of interpretation.

Bearing upon the question of the relation of fertilizers to infection is the following experiment, which was begun with other matters in view. Five five-inch pots were filled about one-third

TABLE V

COMPARISON OF THE NUMBER AND SIZE OF SPOTS ON PLANTS TREATED WITH SODIUM NITRATE AND HYDRATED LIME. NOTES TAKEN TWENTY DAYS AFTER INOCULATION

Treatment	Plant No.	Leaf No.	Diameter of spots in millimeters										Aver.	No. spots per plant	No. leaves per plant
			1	2	3	4	5	6	7	8	9	10			
Hydrated lime	1	1	0.5	0.5	0.5	0.5	0.5	0.5	1.0	0.5	1.0	0.5	0.60	113	5
		2	1.0	0.5	0.5	0.5	0.5	0.5	1.0	0.5	0.5	0.5	0.60		
		3	0.5	0.5	1.0	0.5	0.5	0.5	0.5	1.0	0.5	0.5	0.60		
	2	1	5.0	3.0	5.0	3.0	3.5	3.0	3.0	5.0	6.0	4.0	3.95	159	6
		2	2.5	2.0	1.0	1.0	2.0	1.0	2.0	1.5	1.0	1.0	1.50		
		3	3.0	2.0	1.0	0.5	1.0	0.5	1.5	1.0	0.5	0.5	1.15		
		4	0.5	1.5	1.0	0.5	1.0	0.5	1.0	1.0	0.5	1.0	0.85		
		5	0.5	1.0	0.5	0.5	0.5	0.5	0.5	1.0	0.5		0.61		
	3	1	1.5	1.0	1.5	2.0	4.0	1.0	0.5	1.0	3.0	1.0	1.65	159	6
		2	1.0	1.0	1.0	1.0	0.5	0.5	1.0	0.5	0.5	2.0	0.90		
		3	1.0	0.5	1.0	1.0	0.5	0.5	1.0	0.5	0.5	1.0	0.75		
	4	1	0.5	1.0	0.5	1.0	0.5	1.0	1.5	1.0	1.0	0.5	0.85	135	5
		2	1.0	1.5	0.5	0.5	1.0	0.5	1.0	0.5	1.0	1.0	0.85		
		3	0.5	1.0	0.5	1.0	1.0	0.5	1.0	1.5	0.5	1.0	0.85		
	5	1	1.0	1.5	1.0	0.5	1.0	0.5	0.5	1.0	0.5	1.0	0.85	36	6
		2	0.5	0.5	0.5								0.50		
		3	1.0	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	1.0	0.60		
Sodium nitrate	1	1	3.0	2.5	5.0	4.0	6.0	4.0	3.0	4.0	4.0	7.0	4.25	459	7
		2	5.0	5.0	5.0	5.0	5.0	6.0	5.0	6.0	7.0	6.0	5.40		
		3	4.0	3.0	3.0	5.0	1.0	3.0	3.0	1.5	3.0	3.0	2.95		
		4	2.0	2.0	1.0	1.0	1.0	1.5	2.0	1.5	1.5	2.0	1.55		
	2	1	7.0	6.0	5.0	6.0	6.0	6.0	6.0	7.0	5.0	5.0	5.90	314	8
		2	3.0	4.0	5.0	4.0	5.0	4.0	2.0	3.0	3.0	3.0	3.60		
		3	3.0	5.0	7.0	4.0	5.0	2.5	4.0	1.5	2.5	5.0	3.95		
		4	2.0	4.0	3.0	1.0	3.0	4.0	3.0	3.0	4.0	2.5	2.95		
		5	2.0	1.0	2.0	1.5	1.5	2.0	2.5	1.0	2.0	1.5	1.70		
	3	1	2.0	3.0	2.0	3.0	3.0	1.5	1.0	2.0	2.0	1.0	2.05	177	9
		2	1.5	1.0	1.5	2.0	1.0	1.5	1.0	1.0	1.0	1.0	1.15		
		3	1.5	0.5	1.0	1.0	0.5	1.0	1.0	1.0	3.0		1.16		
	4	1	5.0	2.0	1.0	2.5	3.5						2.80	145	10
		2	1.5	6.0	3.0	1.5	4.0	2.0	4.0	1.0	3.0	1.0	2.70		
		3	2.0	2.0	3.0	4.0	2.5	3.5	2.0	1.0	2.0	4.0	2.60		
		4	3.0	3.5	2.0	2.0	3.0	2.0	3.0	3.0	1.5	1.0	2.40		
		5	1.0	0.5	0.5	3.0	2.0	1.0	0.5	1.0	0.5	1.0	1.10		
		6	0.5	0.5	1.0	1.5	1.5	1.0	0.5	0.5	1.5	1.0	1.05		
	5	1	2.0	3.5	3.5	3.0	1.0	1.0	0.5	1.0	0.5	3.0	1.90	325	7
		2	3.0	3.0	2.0	2.0	4.0	1.0	3.0	1.0	2.5	2.5	2.40		
		3	1.0	1.0	2.0	2.0	2.0	2.0	2.5	3.0	3.5	2.0	2.10		
		4	1.0	0.5	0.5	0.5	2.0	0.5	1.0	0.5	0.5	1.0	0.85		

full with heavily diseased leaves and petioles of celery. Five pots were similarly filled with healthy green leaves. Celery plants were potted in garden soil in the upper part of these pots and twenty days later these plants were inoculated. The result was a very decided increase in infection upon the plants which received the diseased material (TABLE VI). While there was no perceptible

TABLE VI

INFECTION ON PLANTS TREATED WITH DISEASED CELERY LEAVES IN THE SOIL

Plant No.		1	2	3	4	5	Average No. spots per leaf
Plants with diseased material	Spots per plant.....	260	288	372	361	153	38.7
	Leaves per plant...	9	7	6	9	6	
Controls	Spots per plant.....	159	217	255	132	187	19.7
	Leaves per plant...	13	7	13	8	7	

difference in the appearance of the two series of plants, the most reasonable explanation of these results is that the diseased material with decay already under way would supply, at the time of inoculation, a condition similar to that produced by the application of manure made in an earlier experiment. The depth at which the material was buried and the uniformity in time with which the infection appeared preclude the possibility of the action of this material as an additional source of inoculum.

INFECTION OF PLANTS INFESTED BY NEMATODES

Perhaps the most conclusive data bearing on the relation of health to infection were obtained incidentally in the course of experiments planned for other purposes. Twelve plants which had received various treatments were given two successive inoculations, which produced at most only a few spots. These were finally thrown out and the roots were found to be heavily infested by nematodes. Again nine plants were set aside from a variety test as possibly resistant individuals. These were also found to be infested. The infection (*Septoria*) on these plants is compared with that on two non-infested plants of the same experiment in TABLE VII. So far as these observations extend, nematodes do not develop to any marked degree on any except badly pot-bound plants. However, a number of galls may be produced on the roots of plants in fairly good growing condition. A number

TABLE VII

REDUCTION IN NUMBER OF SPOTS PRODUCED BY SEPTORIA ON PLANTS INFESTED BY NEMATODES

Variety	Infested by nematodes									Not infested	
	Winter Queen	Winter Queen	Winter Queen	White Plume	White Plume	New Rose	Golden Half Dwarf	Golden Half Dwarf	Golden Half Dwarf	New Rose	Golden Self Blanching
No. of leaves	5	4	5	5	5	5	5	7	4	4	4
Spots per plant	15	8	5	56	19	12	19	5	29	503	385

of these cases were noted in connection with the fertilizer experiments previously described, in which no reduction in vigor of the plant or in the amount of infection could be detected. An attempt to produce the infestation by inoculation into the soil was made with ten young plants in good growing condition but at the end of ten weeks, no galls were evident. The history of a single plant which has been followed more closely will throw light on the rôle which the nematode plays here. A plant was noted as "highly resistant" in the course of an experiment and when reinoculated it had lost its susceptibility completely. The roots were very heavily infested by nematodes. The plant was placed in a larger pot with fresh soil and five weeks later, when considerable growth had been made, it was again inoculated with a control. At the end of twenty-eight days no spot recognizable as due to *Septoria* could be found on the plant. The control plant bore 219 spots. Seven weeks after this inoculation the "nematode" plant was treated with 300 c.c. of the nutrient solution described above with the fertilizer experiments. At this time a few small spots could be seen with an occasional pycnidium. The plant was finally inoculated six days after the addition of the fertilizer and thirty days later a count of 478 spots was obtained. These spots were for the most part small and the fructification of the fungus was feeble. According to the accounts of the behavior of nematodes in the roots of plants, it seems clear that the foliage is starved both by the disruption of the vascular elements and by the withdrawal of food materials to produce the galls. Here is undoubtedly a clear case of the reduction of infection by a fungus parasite running parallel with the reduction in vigor of the host.

INFECTION OF ETIOLATED PLANTS

The effect of etiolation of the host upon infection has been tested in various ways. The first series of plants were kept in a dark room for nine days just preceding inoculation. Controls were kept on the greenhouse benches. The counts of spots per plant are shown in TABLE VIII. This prolonged period in the

TABLE VIII

EFFECT UPON INFECTION PRODUCED BY ETIOLATING PLANTS FOR NINE DAYS IMMEDIATELY PRECEDING INOCULATION

Plant No.	1	2	3	4	5	6	Total No. leaves	Average No. spots per leaf
Etiolated	62	172	29	63	35	39	50	8.0
Control	33	40	312	253	400	72	64	16.7

total absence of light materially changed the plants in a number of ways. The most noticeable changes were loss of chlorophyll, elongation of the petiole, and reduction in size of the leaflets. The reduction in leaf area, however, was plainly not commensurate with the difference in amount of infection. Neither can the suspension of photosynthesis be held entirely accountable for the less vigorous action of the parasite, in view of the various other changes in the host and in the light of the following further experiments.

The second series of plants were kept in the dark room for three and one half days immediately following their removal from the inoculation chamber. The plants were not materially changed in appearance and it may be seen at once in TABLE IX that no

TABLE IX

EFFECT OF ETIOLATION FOR THREE AND ONE-HALF DAYS FOLLOWING THE REMOVAL OF PLANTS FROM THE INCUBATION CHAMBER

Plant No.	1	2	3	4	5	6	Total No. leaves	Average No. spots per leaf
Etiolated	422	163	313	584	403	565	48	50.9
Control	623	368	495	350	342	382	47	54.4

noteworthy variation was produced in the amount of infection as compared with the control plants. It was noted moreover

that the time* required for the first appearance of the spots was practically identical for the etiolated and control plants.

A third set of plants was kept in the dark room for five days, beginning on the thirteenth day after inoculation, at which time the spots were just beginning to appear. This dark room was provided with a ventilator which caused a continuous circulation of air from the greenhouse in which the control plants were kept thus providing similar atmospheric conditions for the two sets of plants. This experiment was performed during the warm weather of July, and as a result the plants kept in the dark room lost several of the older leaves. Although the total counts of infections could not be obtained it is scarcely to be expected that the number of spots would be altered by this treatment.

TABLE X

EFFECT ON SIZE OF SPOT OF ETIOLATION AT DIFFERENT TIMES RELATIVE TO INOCULATION

a. Plants kept in dark room nine days preceding inoculation

Plant No.	Etiolated plants		Control plants	
	Average size spot	No. of leaves	Average size spot	No. of leaves
1	1.62	5	1.17	6
2	1.51	5	1.16	9
3	1.37	4	0.91	4
4	1.54	3	0.95	8
5	1.45	3	0.94	4
b. Plants kept in the dark room from the fifteenth to the eighteenth day after inoculation				
1	2.08	3	1.27	2
2	1.87	2	1.51	4
3	1.50	2	1.07	5
4	1.80	1	1.81	3
5	1.75	2	1.45	3
6	1.78	3	1.33	3

This seemed to be borne out by counts from the individual leaves. The effect upon the size of the spot produced by etiolation at this time was readily demonstrable. TABLE X shows the increase in diameter of spots upon plants etiolated both before and after inoculation. Except for an occasional leaf (nine altogether)

* Fromme found (12) that *Puccinia coronifera* on oats was almost completely arrested in its progress during the time in which inoculated plants were kept in the dark room.

ten spots per leaf were measured. Thus for a plant of five leaves fifty spots were measured.

In the case of the first series kept in the dark room before inoculation, the most marked increase in the size of the spots was on the youngest leaves, which were put out partly or entirely while the plants were in the dark room. On these the spots at times exceeded in diameter those on the oldest leaves. In the last series of plants the increase in size apppeared to be proportionate for all the spots. It has been noted that when infected plants are placed in the inoculation chamber, for forty-eight hours, a zone of at least one half to one millimeter surrounding each spot is broken down. That the mycelium of *Septoria* should advance this distance in so short a time does not seem probable. It appears rather that the weakened tissues of the host plant succumb where the fungus is already present.

RELATION OF TEMPERATURE TO INFECTION

It has been recognized since the late blight disease began to be studied that it is more severe in the early autumn than during mid-summer. I have found this to be true in the greenhouse as well as in the field. Several experiments have been performed to test the relation of this condition to temperature. Plants were inoculated uniformly and divided into two groups which were kept through part or all of the incubation period at temperatures

TABLE XI

EFFECT OF MAINTAINING INOCULATED PLANTS AT DIFFERENT TEMPERATURES THROUGHOUT THE INCUBATION PERIOD OF TWENTY-ONE DAYS

Mean av. temperature	Number of infections per plant										
	1	2	3	4	5	6	7	8	9	10	Average
21.9° C.	383	272	327	281	189	377	98	133	209	269	253.7
13.3° C.	144	86	120	52	3	64	111	73	104	37	79.4

differing from 7 to 13 degrees Centigrade (mean average). Five sets of from ten to twenty plants each were inoculated. The infection develops more rapidly at higher temperatures but later counts show usually no striking difference and the individual plants vary widely. One set (TABLE XI) showed a marked though not altogether consistent difference in counts. However,

a second record five days after the first showed an average increase of fifteen spots per plant on the plants of the lower temperture. One set of plants showed a consideraby higher count on the plants of lower temperature after thirty-six days. The results are too variable to be in any way conclusive. A factor of probably greater importance is the fact that the host plant may be more vigorous and make its greatest growth in cool weather with the autumn rains. Rolfs (32) states that in Florida celery can be grown only as a cool weather crop. Lloyd (20) and Watts (41) point out that celery demands cool weather, at least cool nghts, for satisfactory growth. However, I have not found any specific data to show the optimum temperature for the culture of celery.

RELATION OF AGE TISSUE TO INFECTION

The absence of any conspicuous sign of infection in the field during the early and middle parts of the growing season led the earlier workers to believe that young plants were affected only slightly or not at all. The more careful observations of later workers have already disproved this. I have observed the fungus on plants in the various stages from the seed bed to maturity.

TABLE XII

NUMBER OF SPOTS ON LEAVES OF DIFFERENT AGES TWENTY-SEVEN DAYS AFTER INOCULATION

Leaf No.*	1	2	3	4	5	6	7	8	9	10
Plant No. 1	0	0	18	209	254	75	17	50		
" 2	0	0	35	193	61	79				
" 3	0	0	5	93	185	127	44	41		
" 4	0	0	0	40	95	136	26	25	24	4
" 5	0	0	52	216	36	27	11			
" 6	0	0	39	194	42	67	31	9		
Totals	0	0	149	945	673	511	129	125	24	4

In the field a row of young plants was set out on July 17 so that they were about half grown when the infection was becoming severe on the regular crop (late September). Counting the number of spots per leaf is not practicable under field conditions but it was obvious that these young plants were attacked with a severity quite sufficient to throw doubt on the idea of a close

* The leaves are numbered here from the center of root crown outward, i.e., from youngest to oldest.

TABLE XIII

SIZE OF SPOT (DIAMETER IN MILLIMETERS), AS AFFECTED BY AGE OF THE LEAF. THESE SPOTS WERE MEASURED ON THE BASAL LEAFLET PAIR OF EACH LEAF NINETEEN DAYS AFTER INOCULATION. LEAF NO. 1 IS THE OLDEST

Spot No.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	Average	No. of spots	Condition of leaf
Leaf No. 1....	1.0	2.0	2.0	3.0	3.0	2.0	2.0	2.0	1.5	1.5	2.0	1.5	5.0	4.0	2.5	2.0	3.0	2.0	1.0	2.0	2.0	2.0	3.0	2.5	2.0	2.26	159	Yellowed, drying
" 2....	1.5	1.5	1.0	1.0	1.0	1.5	2.0	1.5	1.5	1.0	1.0	0.5	1.0	0.5	1.5	1.5	1.5	2.5	2.0	1.0	1.0	2.5	0.5	1.0	2 0	1.34	305	Yellowing
" 3....	1.0	1.5	1.5	2.0	2.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	0.5	1.5	2.0	0.5	2.5	2.0	1.0	1.0	1.0	1.5	1.30	379	Yellowing slightly
" 4....	2.0	1.5	1.5	1.0	1.0	1.0	1.0	1.0	1.5	2.5	1.0	1.0	1.5	1.5	2.0	2.0	2.0	0.5	1.0	1.0	0.5	2.0	1.5	1.5	0.5	1.34	212	Green
" 5....	1.0	0.5	1.0	1.5	1.0	1.0	0.5	0.5	0.5	0.5	1.0	1.0	0.5	1.0	0.5	1.0	2.5	1.0	0.5	1.0	1.0	1.5	1.0	1.0	1.0	0.94	209	"
" 6....	1.0	1.0	0.5	0.5	0.5	.05	0.5	0.5	1.0	1.0	0.5	0.5	1.5	1.0	1.0	0.5	1.0	0.5	1.0	0.5	1.0	0.5	1.0	1.0	0.5	0.76	114	"
" 7....	0.5	0.5	1.0	1.0	1.5	1.0	1.0	0.5	0.5	0.5	0.5	0.5	0.5	0.5	1.0	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	1.0	1.0	0.68	90	"

relation between the age of the plant and its susceptibility. However, as regards the relative susceptibility of leaves of different ages on the same plant, results have been obtained to show that there is a definite and constant relation between the age of the leaf and the number of spots produced by inoculation (TABLE XII).

The leaves which show no infection are those which were pushed out after the inoculation was made. It has been determined by tagging the young leaves at the time of inoculation that a leaf is susceptible as soon as it pushes out into view. It does not however unfold the leaflets so as to be exposed to the inoculum on all its surface until it has reached a height of from two to four inches. This accounts in part for the smaller count on the very young leaves. No method has been devised to determine whether or not these leaves are as susceptible per unit area as leaves which have completely unfolded. The chief point of interest here is that a very much larger number of infections is established on leaves which are still actively growing than on leaves which are more mature. Another very interesting difference in the behavior of leaves

of different ages in relation to fungus invasion is found in the rate of breaking down of the leaf tissue after infection becomes established. Except in unusual cases in the greenhouse there was little coalescing of spots until some days after the infection was evident on all of the leaves. Thus time was allowed for measurement of the size of spots even on very old leaves while they were still distinct in outline. It was found that for a given distance between spots, the older the leaf the more rapidly the intervening tissue breaks down.

TABLE XIII shows the diameter measured to the nearest half millimeter of twenty-five spots on each leaf of a plant nineteen days after inoculation. The marked decrease in the size of the spots from the oldest to the youngest leaf is at once apparent.

In TABLE XIV the averages are shown for a number of other plants which were similarly studied. It has been pointed out that the margin of the killed area produced by *Septoria* is not identical with the limit of mycelial spread. Whether or not the fungus colony exceeds the margin of the spot as far in old leaves as in young leaves has not been determined.

TABLE XIV

AVERAGE SIZE OF SPOTS ON LEAVES OF THE SAME PLANT AT DIFFERENT AGES

Leaf No.	1	2	3	4	5	6	7	8	9	No. spots measured*	Age of infection
Plant No. 1....	2.18	1.22	0.94	0.72	0.64					25.0	19 days
" 2....	1.32	0.88	0.74	0.74						25.0	19 "
" 3....	1.66	1.06	0.86	0.80	0.58					25.0	19 "
" 4....	1.30	1.10	1.00	0.55						10.0	29 "
" 5....	1.45	0.70	0.70	0.70						10.0	29 "
" 6....	1.80	1.40	1.25	1.20	0.80	0.60				10.0	29 "
" 7....	1.30	1.35	1.15	0.70	0.90	0.75	.77	.62		10.0	29 "
" 8....	2.05	2.00	1.20	1.00	0.95	0.95	.80	.75	.75	10.0	29 "

A possible relation between the acidity of plant juices and their susceptibility to fungus attack has been claimed by Comes (**6**). With this in mind two lots of leaves were collected from a number of celery plants, the oldest being included in one lot and the youngest in another. These were put through a meat grinder and 15 gram samples of each were extracted for thirty minutes in 200 cc. distilled water. The extracts were filtered and 100 cc. of the filtrate were titrated against approximately twentieth normal

* In four leaves less than the number of spots indicated was used.

sodium hydrate solution. A very marked increase in acidity was thus shown for the old leaves. The ratio of the readings for young and old leaves was 4.6 : 6.3.

Sorauer (36) states that acidity is higher in etiolated plants than in the normal green. It has been pointed out that young leaves developed in the dark room bear spots as large as those produced on very old leaves. This suggests the possibility of a relation between the size of the spot and the acid content of the leaf. Obviously, however, no more than a suggestion can be made from the data at hand.

DISCUSSION

The relations of host and parasite are apparently as different for the groups of saprophyte, semi-saprophyte, and obligate parasite as are the modes of life of the organisms. It is possible to arrange an intergrading series according to the completeness of adaptation to the host, from a form such as *Botrytis* (see Blackman and Welsford, 2), which habitually kills the host cells before it reaches them and is probably never in intimate contact with the living cell, to a form such as the seed fungus of *Lolium temulentum* (see Freeman, 11), which has reached such a high degree of adjustment with the host that it is perpetuated entirely in the mycelial form through the seed of the host and perhaps never kills any of the host cells. As the adaptation to the host becomes more nearly complete, there is an increasing tendency to show some of the features of mutualism and symbiosis. Fromme (13) has observed with the angular leaf spot of tobacco and Peltier (25) with citrus canker that infection is heavier under conditions which favor the growth of the host. Marchal (21) found that infection of lettuce by *Bremia Lactucae* was favored by nitrogen and phosphates and retarded by an excess of potash. The experiments described in this paper show that *Septoria Apii*, although it readily assumes the saprophytic habit, has become so adapted to its host that the development of infection is favored by increased growth in the host, such as is produced by feeding the plants with nitrates, with a complete nutrient solution, or by top dressing the soil with sheep manure. The acceleration is manifested in both the number of infections

established and the size of the spots produced. On the other hand top dressing the soil of pots with lime decreases the infection. Also the infestation of the roots of celery plants by nematodes partially or entirely inhibits the development of the fungus. The retention of chlorophyll and water in the tissue adjacent to infected spots after these have disappeared from the remainder of the leaf is further evidence of a tendency toward mutualism between the fungus and host. McCue (**22**) observed that tomato plants treated with phosphatic fertilizers developed less leaf blight (presumably *Septoria*) than control plants, while those on nitrogen and potash plots were more heavily infected than the controls. At the same time the highest yields (showing greatest vigor of growth), were obtained from the plants which received nitrogen and potash. Norton (**24**) also noted a decrease in infection by *Septoria* on tomatoes treated with phosphates.

Cereals grown by Spinks (**37**) in nutrient solution seemed to be susceptible to infection by *Erysiphe* in proportion as vigorous growth of the host was maintained. Excess of phosphates and potash diminished susceptibility while nitrates increased it. Stakman (**38**) noted that heavy manuring of rye increased the number of successful inoculations with *Puccinia graminis Avenae*. Even the seed fungus, however, is surpassed in some mutualistic characters by the mycorrhizas and lichens. The mycorrhizas show grades of interrelation between host and parasite from active parasitism to finely adjusted mutualism. Stout (**39**) has shown that *Sclerotium rhizodes* may be parasitic on aerial parts of *Calamagrostis canadensis* and at the same time assume a mycorrhizal habit on the roots of the same host. Nieuberg (**23**) found that in the lichens mutualism persists for a long period perhaps even after the fungus finally penetrates the algal cells. This habit is a close approach to that of producing haustoria as in the more specialized parasites.

With the exception of the nitrogen fixing bacteria, only the mycorrhizal and lichen fungi have been proven to contribute anything of value to the host. It is important, however, in the development of methods of avoiding disease in plants, as well as for a clearer understanding of the nature of parasitism, that it be recognized that the relation of host and parasite is not of necessity

antagonistic throughout but may on the contrary become specialized in such a way that infection and the development of the typical symptoms of the disease are directly favored by the general vigor of the host plant.

In the relation of the age of different tissue on the same celery plant to infection, it seems that there are two entirely separate conditions operating, one which governs the establishment of infection and another which determines the rate of subsequent spread of the mycelium. The first stage seems closely related to the immediate metabolic activity of the host cells especially in view of the marked increase in the number of infections produced by the addition of fertilizers to the plant at the time of inoculation. That starch metabolism has no very direct relation to infection is indicated by the results of inoculating etiolated plants.

Pool and McKay (**28**) state that the infection of *Beta vulgaris* by *Cercospora beticola* is closely related to, if not directly controlled by the movement of the stomata. According to their data (pp. 1019, 1031), however, heart leaves which are said not to be infected show an average stomatal pore width of from 0 μ to 9 μ between 10 A.M. and 1 P.M., only one case in ten falling below 2.5 μ. Celery leaves can be infected as soon as they come into view but they frequently reach their mature height before the spots are visible. It is not clear whether the incubation period is taken into consideration in this connection by Pool and McKay. They do not show comparative counts on old and young leaves from a single infection. These authors show a close correlation between the maturity of the leaf and the number of stomata per unit area. Ensign (**10***a*) has shown a very definite relation between the size of the vein-islets and maturity of the leaf in citrus. The relation of infection to age of the host as determined by these criteria deserves further attention.

It has been pointed out that the tissue between spots separated by a given distance will break down more rapidly on old leaves than on young ones. It has been noted furthermore that from a single inoculation the spots are visible on the old leaves one to several days before they can be seen on the younger leaves.

The *Septoria* produces a vigorous growth on widely different culture media, as well as on cooked celery, but at the same time

is unable to develop on a living host as nearly related to celery as is parsley.

The comparatively narrow specialization of the *Septoria* on celery suggests a promising outlook for experiments in breeding for resistance. More intensive work in this direction is needed.

This work was done in the laboratory of Professor R. A. Harper and acknowledgment is herewith made to him for numerous helpful criticisms and suggestions.

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LITERATURE CITED

1. **Beach, W. S.** Biologic specialization in the genus *Septoria*. Am. Jour. Bot. **6**: 1–33. 1919.
2. **Blackman, V. H., & Welsford, E. J.** Studies in the physiology of parasitism. II. Infection by *Botrytis cinerea*. Ann. Bot. **30**: 389–398. *pl. 10 + f. 1, 2.* 1916.
3. **Briosi, G., & Cavara, F.** I funghi parasitti della piante coltivate ed utili. Fasc. **6**: No. 144. 1890. [Original not seen].
4. **Chester, F. D.** Notes on three new or noteworthy diseases of plants. Bull. Torrey Club **18**: 371–374. 1891.
5. **Clinton, G. P.** Report of the Botanist. Conn. Agr. Exp. Sta. Ann. Rept. **1905**: 263–330. *pl. 13–25.* 1906.
6. **Comes, O.** Connection between acidity of cell sap and rust resistance in wheat. [Review of original]. Bull. Agr. Int. and Pl. Dis. **4**: 1117–9. 1913.
7. **Cooke, M. C.** Fungoid pests of cultivated plants. London. 1906.
8. **Coons, H. H., & Levin, E.** *Septoria* leaf spot disease of celery or celery blight. Mich. Agr. Exp. Sta. Spec. Bull. 77: 1–8. *f. 1–9.* 1916.
9. **Dorogin, G. N.** Melanose of celery. Mat. Miko. i Fitopatol. Ross. **1**: 57–76. *f. 1–9.* 1915.
10. **Duggar, B. M., & Bailey, L. H.** Notes on celery. New York (Cornell) Agr. Exp. Sta. Bull. 132: 206–215. *f. 51–53.* 1897.
10a. **Ensign, M. R.** Venation and senescence of polyembryonic citrus plants. Amer. Jour. Bot. **6**: 311–329. *f. 1–6.* 1919.
11. **Freeman, E. M.** The seed fungus of *Lolium temulentum* L., the darnel. Phil. Trans. Roy. Soc. Lond. **196**B: 1–27. *pl. 1–3.* 1903.
12. **Fromme, F. D.** The culture of cereal rusts in the greenhouse. Bull. Torrey Club **40**: 501–521. 1913.

13. —— **& Murray, T. J.** Angular-leafspot of tobacco, an undescribed bacterial disease. Jour. Agr. Research **16**: 219–228. *pl. 25–27.* 1919.

14. **Howitt, J. E.** Experiments to control the late blight of celery. Ann. Rept. Ontario Agr. Coll. and Exp. Farm **39**: 45–46. 1914.

15. **Humphrey, J. E.** Report of the department of vegetable Physiology. Mass. Agr. Exp. Sta. Ann. Rept. **1891**: 218–248. 1891.

16. **Kinney, L. F.** Celery Culture in Rhode Island. Rhode Island Agr. Exp. Sta. Bull. 44: 17–63. *f. 1–19.* 1897.

17. **Klebahn, H.** Krankheiten des Selleries. Zeitschr. Pflanzenkr. **20**: 1–40 *f. 1–14.* 1910.

18. **Krout, W. S.** Report on diseases of celery. New Jersey Agr. Exp. Sta. Rept. Dept. Plant Path. **1916**: 584–603. 1916.

19. **Link, G. K. K., & Gardner, M. W.** Market pathology and market diseases of vegetables. Phytopathology **9**: 497–520. 1919.

20. **Lloyd, J. W.** Productive vegetable growing. Philadelphia. 1914.

21. **Marchal, E.** De l'immunization de la laitue contre le meunier. Compt. Rend. Acad. Sci. Paris **135**: 1067–1068. 1902.

22. **McCue, C. A.** Tomatoes for the canning factory. Delaware Agr. Exp. Sta. Bull. 101: 18. 1913.

23. **Nieuberg, W.** Über die Beziehungen zwischen den Algen und Hyphen im Flechtenthallus. Zeitschr. Bot. **9**: 529–545. 1917.

24. **Norton, J. B. S.** Internal action of chemicals on resistance of tomatoes to leaf disease. Maryland Agr. Exp. Sta. Bull. 192: 17–30. *f. 1.* 1916.

25. **Peltier, G. L.** Susceptibility and resistance to citrus-canker of the wild relatives, citrus fruits and hybrids of the genus *Citrus.* Jour. Agr. Research **14**: 337–358. 1918.

26. **Pethybridge, H. G.** The possible source of the origin of the leaf spot disease of cultivated celery. Jour. Roy. Hort. Soc. **40**: 476–480. 1914.

27. **Pfeffer, W.** The physiology of plants. Ewart's edition. Oxford. 1900–1906.

28. **Pool, V. W., & McKay, M. B.** Relation of stomatal movement to infection by *Cercospora beticola.* Jour. Agr. Research **5**: 1011–1058. *pl. 80, 81 + f. 1–6.* 1916.

29. **Prillieux, E. E., & Delacroix, G.** Sur quelques champignons nouveaux ou peu connus parasites sur les plantes cultivées. Bull. Soc. Mycol. France **10**: 161–162. 1894.

30. **Quanjer, H. M., & Slagter, N.** De roest- of schurftziekte van de selderieknol en énkele opmerkingen over andere selderieziekten. Tijdschr. over Plantenziekten **20**: 13–27. *pl. 1.* 1914.

31. **Rogers, S. S.** The late blight of celery. California Agr. Exp. Sta. Bull. 208: 83–115. *f. 1–17.* 1911.
32. **Rolfs, P. H.** Subtropical vegetable gardening. New York. 1916.
33. **Rostrup, E.** Gardners' Tidende 1893, p. 180. [Original not seen.]
34. **Salmon, E. S.** Celery blight or rust (*Septoria Petroselini* var. *Apii*) and its prevention. Gard. Chron. **53**: 414–416. *f. 176–181*; **54**: 3–4. *f. 4.* 1913.
35. **Sorauer, P.** Die Fleckenkrankheit des Selleries. Zeitschr. Pflanzenkr. **6**: 191–192. 1896.
36. —— . Handbuch der Pflanzenkrankheiten. **1**: 664, Berlin. 1909.
37. **Spinks, G. T.** Factors affecting susceptibility to disease in plants. Part I. Jour. Agr. Sci. **5**: 231–247. 1913.
38. **Stakman, E. C.** A study in cereal rusts. Physiological races. Part I. Biologic forms. Minnesota Agr. Exp. Sta. Bull. 138 5–56. *pl. 1–9.* 1914.
39. **Stout, A. B.** A *Sclerotium* disease of blue joint and other grasses. Wisconsin Agr. Exp. Sta. Research Bull. 18: 207–261. *f. 1–8,* 1911.
40. **Ward, H. M.** Experiments on the effect of mineral starvation on the parasitism of the uredine fungus *Puccinia dispersa* on species of *Bromus.* Proc. Roy. Soc. Lond. **71**: 138–151. *f. 1–4.* 1902.
41. **Watts, R. L.** Vegetable gardening. New York. 1918.
42. **White, T. H.** Variety tests of potatoes, tomatoes, cabbage and other vegetables. Maryland Agr. Exp. Sta. Bull. 204. 246: 247. 1917.
43. **Zobel, H. F.** Celery diseases. Gard. Chron. **55**: 95. 1914.

New species of Uredineae—XIII*

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The present paper in the author's series of new species is made up partly of newly discovered species and partly of old species requiring a change of specific or generic names. There is also a substitution of two new generic names and one old one for untenable ones. When preparing the classification of the Uredinales, announced by the writer before the Vienna Botanical Congress in 1906, it was necessary to work with much imperfectly studied material. As the classification was based upon life histories, and as the life cycle of the majority of species was then unrecorded and largely unknown, a number of errors were made due to erroneous assumptions. These errors are being corrected as knowledge of the rusts increases, and a number are taken in hand at this time. The genera to which attention is now directed are *Lysospora*, *Telospora* and *Dasyspora*, as they were given in the Vienna paper.

Puccinia pacifica Blasdale, sp. nov.

II. Uredinia amphigenous, more abundant beneath, thickly scattered, irregularly rounded, 0.3–1 mm. across, at first bullate, soon naked, somewhat pulverulent, dark chestnut-brown, ruptured epidermis very conspicuous; urediniospores ellipsoid or obovate, 22–26 by 26–32 μ; wall chestnut-brown, 2–3 μ thick, finely echinulate, the pores 2, equatorial.

III. Telia similar to the uredinia but somewhat darker and less pulverulent; teliospores oblong or obovate-oblong, 20–24 by 38–48 μ, rounded or obtuse above, obtuse or narrowed below, somewhat constricted at septum; wall chestnut-brown, lighter below, 1–1.5 μ thick, thicker above, 3–7 μ, smooth; pedicel colorless, fragile, once or twice length of spore when unbroken, 7–9 μ in diameter.

On *Plantago maritima* L., Montara Point, San Mateo County, California, August 7, 1920, *W. C. Blasdale 1108*. A specimen of

*Contribution from the Botanical Department of Purdue University Agricultural Experiment Station.

this interesting new rust was sent to the writer immediately upon its discovery, with the name and permission to publish. It was found in considerable abundance on a bluff overlooking the Pacific Ocean.

Puccinia irrequisita Jackson, sp. nov.

II. Uredinia amphigenous, scattered, round, 0.3–0.5 mm. across, early naked, pulverulent, cinnamon-brown, ruptured epidermis conspicuous; urediniospores globoid or broadly ellipsoid, 20–23 by 23–26 μ; wall cinnamon-brown, 1–1.5 μ thick, moderately and finely echinulate, the pores three, equatorial.

III. Telia amphigenous, chiefly epiphyllous, scattered, round, 0.3–0.5 mm. across, tardily naked, pulvinate, blackish brown, or grayish from the overlying epidermis; teliospores irregularly ellipsoid, somewhat angular, 24–29 by 34–40 μ, rounded or obtuse above, rounded or truncate below, scarcely constricted at septum; wall chestnut-brown, 3–3.5 μ thick, not appreciably thickened above, obscurely and very finely verrucose; pedicel colorless, short, deciduous.

On *Centaurea americana* Nutt., Austin, Texas, April 6, 1901, II (Ellis & Ev. Fungi Columb. *1642*); same, June 5, 1901, II, III (type) (Barth. N. Am. Ured. *1338*). Both collections were made by W. H. Long. This species is similar to *Puccinia Centaureae* Mart., with which it has been listed. It differs from that species in the more irregular teliospores with their considerably thicker walls, and in the tardily naked telial sori. These differences, taken together with the fact that the host is not an introduced one but native, makes it seem best to consider the species strictly American. The particular study of it has been made by Professor H. S. Jackson, who has supplied the diagnosis.

Puccinia additicia Jackson & Holway, nom. nov.

Puccinia Coreopsidis Jackson & Holway; Arth. Am. Jour. Bot. 5: 536. 1918.

My attention has been called by Professor H. S. Jackson to the publication of *Puccinia Coreopsidis* Wakefield, from tropical Africa, in the Kew Bulletin for 1918, page 209. The part in which this name, with description and illustration, appears was issued in August, 1918, thus antedating the publication of the Guatemalan name by four months. The two rusts are entirely distinct, thus

necessitating a new name for the latter, which has been supplied by Professor Jackson as above.

Puccinia opposita (Orton) comb. nov.

Allodus opposita Orton, Mem. N. Y. Bot. Gard. **6**: 185. 1916.

This species is still only known from the type collection on *Anemone globosa* Nutt., from Sulphur Springs, Colorado.

Puccinia Erigeniae (Orton) comb. nov.

Allodus Erigeniae Orton, Mem. N. Y. Bot. Gard. **6**: 191. 1916.

The type collection on *Erigenia bulbosa* (Michx.) Nutt. was made by J. Dearness at London, Canada, in 1892, and distributed in Ellis's North American Fungi, No. *1040b*, under the name of *P. Pimpinellae*, and showed both aecia and telia. The only other collection known up to the present time was made by F. D. Kelsey at Oberlin, Ohio, April, 1894, showing aecia only.

Uromyces coördinatus sp. nov.

O. Pycnia hypophyllous, scattered abundantly over surface of leaf, preceding and accompanying the aecia, pale- or honey-yellow, barely noticeable, subepidermal, globoid or flask-shaped, 100–140 μ broad; ostiolar filaments 50–75 μ long, protruding above surface of leaf.

I. Aecia hypophyllous, evenly scattered over surface of leaf, at first bullate and opening by a pore, 0.4–0.7 mm. across; peridia erect, or slightly recurved, erose; peridial cells cuboidal or polygonal, 22–24 by 23–29 μ, abutted or slightly overlapping, the outer wall 10–12 μ thick, striate, the inner wall 3–5 μ thick, noticeably verrucose; aeciospores globoid or broadly ellipsoid, 15–19 by 19–24 μ; wall nearly or quite colorless, 1–2 μ thick, finely verrucose.

III. Telia hypophyllous, at first arising from and evenly filling the aecial cups, afterward independently but similarly grouped, the ruptured epidermis appearing like a peridium, somewhat pulverulent, dark chocolate-brown; teliospores irregularly ellipsoid, oblong or obovoid, 16–22 by 17–31 μ; wall cinnamon- or chestnut-brown, 1–2 μ thick, sometimes with a small colorless papilla over the apical pore, closely and noticeably verruccse, inclined at times to be striate; pedicel fragile, colorless, largely deciduous.

On *Tithymalus Palmeri* (Engelm.) Arth. (*Euphorbia Palmeri* Engelm.), Laguna Mountains, California, July 19, 22, 1920; same,

Big Bear Lake, California, July 31, 1920, and August 1, 1920 (type); all collected by E. Bethel, and all showing O, I, and III.

The first specimen received from Mr. Bethel was sent as an *Aecidium*, "with *Uromyces* which appears to belong with it." With the collection of August 1 he inclosed this note: "From field observations I am confident that this *Aecidium* is followed by the *Uromyces*." The specimens sent by Mr. Bethel show clearly that the telia arise from the same mycelium that bore the aecia, as most of the telial sori are contained in the aecial cups.

The aecia are morphologically indistinguishable from those occurring commonly on the same host and similar hosts throughout the Rocky Mountains, and which the writer for a time referred to *Aecidium Tithymali* Arth. (this name to be restricted to forms occurring east of the Rockies), but now believes to be the aecial stage of the heteroecious *Uromyces occidentalis* Sydow.

The teliospores of *U. coördinatus* are indistinguishable from those of *U. occidentalis* on species of *Lupinus* in the same region. Farther east in the Rockies, however, teliospores of this lupine rust are often slightly smaller and paler. The connection of the common Rocky Mountain aecia on *Tithymalus*, not followed by any other spore forms on the same host, with the *Uromyces occidentalis* on *Lupinus* was first pointed out by Mr. A. O. Garrett some three years ago in a letter to the writer, and backed by strong circumstantial evidence. Later Mr. E. Bethel supplied data and independently reached the same conclusion. Although this connection has not yet been established by cultures, it seems reasonably certain.

The teliospores are also scarcely distinguishable from *Uromyces Tranzschelii* Sydow, a short cycle form on the same and similar species of *Tithymalus*. These three species of rusts with different life cycles, form a most interesting group of coördinated species, which eventually under some other classification may possibly be placed under a single name.

Polythelis suffusca (Holway) comb. nov.

Puccinia Pulsatillae Rostr. Cat. Pl. Soc. Bot. Copenhague 1, hyponym. 1881; Vesterg. Bot. Notiser **1902**: 169. 1902. Not *P. Pulsatillae* Kalchbr. 1865.

Puccinia suffusca Holway, Jour. Myc. 8: 171. 1902.
Polythelis Pulsatillae Arth. Résult. Sci. Congr. Bot. Vienne 341. 1906.

The specific name adopted for this species under the genus *Polythelis* in the North American Flora was already preoccupied when the genus *Polythelis* was established, and should not have been taken up. The next older name is now substituted. A history of the name *Puccinia Pulsatillae* is given by Holway in the Journal of Mycology (8: 171. 1902). Kalchbrenner's name applies to the very dissimilar species that occurs on some of the same hosts and is usually listed as *Puccinia DeBaryana* Thüm.

Ravenelia havanensis sp. nov.

O. Pycnia amphigenous, petiolicolous, and on young, swollen shoots, thickly scattered, prominent, punctiform, hemispheric or subconic, smoky-brown, subcuticular, 130–250 μ broad by 65–80 μ high; hymenium flat; ostiolar filaments wanting.

II. Uredinia of the primary form following the pycnia, scattered, of the secondary form epiphyllous and somewhat petiolicolous, in small groups or solitary, subcuticular, soon naked, cinnamon-brown, irregularly rounded, 0.3–0.6 mm. across, ruptured cuticle noticeable; paraphyses wanting; urediniospores obovate-oblong, or linear-oblong, 13–18 by 26–38 μ, rounded or acute above; wall pale- or cinnamon-brown, paler below, 1.5–2 μ thick, sometimes a little thickened above, 2–4 μ, sparsely and prominently echinulate, the pores 4, equatorial.

III. Telia epiphyllous, subcuticular, in irregular groups, early naked, chestnut-brown, ruptured cuticle noticeable; teliospore-heads chestnut-brown, 4–6 cells across, oblong-hemispheric, 65–85 by 65–70 μ across, 45–55 μ high, each spore bearing 4–6, straight, subconical, hyaline tubercles, 2–3 μ long; cysts hyaline, globoid, small, not readily bursting in water; pedicel hyaline, very short.

On *Enterolobium cyclocarpum* (Sw.) Griseb., Capdevila, Havana, Cuba, December 5, 1919, II_2, *J. R. Johnston 1195:* same, May 10, 1920, O, II_1, *J. R. Johnston 1201:* same December 1, 1920, II_2 on seeding plants, III on old tress, *J. R. Johnston* (type). There are two species of *Ravenelia*, both on *Enterolobium Timbouva*, described by Spegazzini from Argentina and Paraguay, the only ones known on this host genus. No mention is made of uredinia in the descriptions, and the writer has not seen material. The Cuban species appears to be abuudantly distinct from the South

American forms, a view which the difference in host species, geographical location, and habit of the rust favor. From the material submitted by Mr. Johnston it seems that the pycnia appear in May, thickly covering young leaves and shoots and causing more or less hypertrophy, and are soon followed by primary uredinia. The secondary uredinia appear some months later unaccompanied by pycnia, and are mostly confined to the upper surface of the leaves, without producing hypertrophy, and on old plants the telia are similarly formed.

Gallowaya pinicola nom. nov.

Coleosporium Pini Gall. Jour. Myc. 7: 44. 1891. Not *C. Pini* Lagerh. 1889.

Gallowaya Pini Arth. Résult. Sci. Congr. Bot. Vienne 336. 1906.

It has been known for some time that the specific name selected by Dr. B. T. Galloway for his rust, which was afterward transferred to the genus *Gallowaya*, had been published some two years earlier by Lagerheim in Mitt. Bad. Bot. Verein, for an entirely different rust. The present occasion is taken to rectify this long-standing mishap by suggesting another specific name.

LIPOSPORA gen. nov.

Cycle of development includes pycnia, aecia and telia. The characters are essentially those of the genus *Tranzschelia* with the uredinia omitted, the following species is taken as the type of the genus.

Lipospora tucsonensis sp. nov.

O. Pycnia chiefly epiphyllous, scattered over large areas, preceding or accompanying the aecia, hemispheric or conic, conspicuous, chocolate-brown, subcuticular, large, 140–160 μ in diameter, 40–100 μ high; ostiolar filaments wanting.

I. Aecia hypophyllous, thickly scattered over large areas, short-cylindric, large, 0.4–0.6 mm. in diameter; peridium ample, divided into few (often 4) widely spreading recurved lobes, white; peridial cells in face view angularly ellipsoid, 22–30 by 28–34 μ, abutted or somewhat overlapping, the outer wall smooth, the inner wall evenly verrucose; aeciospores globoid, 16–20 by 18–22 μ; wall colorless or pale golden-yellow, moderately thin, 1–1.5 μ, closely and minutely verrucose.

III. Telia chiefly hypophyllous accompanying the aecia, gregarious in irregular groups and somewhat confluent or scattered, large and irregular, 1–2 mm. across, dark chocolate-brown, pulverulent, the membranous epidermis soon ruptured but usually partly remaining and conspicuous; teliospores oblong, 18–24 by 32–38 μ, rounded above, rounded or paler and more or less narrowed below, considerably constricted but usually not separating at septum, the two cells of same size and shape or the lower one smaller and narrower; wall dark chestnut-brown or paler in lower cell, uniformly thin, 1–2 μ thick, closely and evenly verrucose; pedicel colorless, short, rarely longer than lower cell, fragile; mesospores not uncommon.

On *Anemone stenophylla* Poepp., Tucson Hills, Arizona, February 29, 1920, *H. W. Thurston*, communicated by *L. N. Goodding 81*.

This genus is characterized as it was intended to characterize the genus *Lysospora*, when that genus was founded in 1906 (Résult. Sci. Congr. Bot. Vienne 340). But the type collection for that genus was Sydow's Uredineen *216*, which consisted of a mixture on the same leaves of aecia of the heteroecious *Tranzschelia punctata* (Pers.) Arth., and telia of the short cycle *Puccinia singularis* Magn., which were inadvertantly assumed to be genetically related. The genus *Lysospora*, therefore, becomes a synonym of *Tranzschelia*, and a new name is supplied for the genus that was in mind in 1906, but for which no representative was known until the present collection came to hand.

The species forms one of the series of four correlated species of which (1) *Tranzschelia punctata*, the plum rust, with a full spored cycle is the heteroecious form; (2) *T. cohaesa* (Long) Arth., also with a full spored cycle is the autoecious form; (3) *L. tucsonensis*, another long cycle form like the last but with the uredinia omitted from the cycle; and (4) *Polythelis fusca* (Pers.) Arth., the short cycle form with only pycnia and telia. The systematic position of these four forms depends upon the views taken of their evolution and the most serviceable method of representing such relationship taxonomically. With slight modification in the description the four species could be combined into one, having four forms of expression. The author, however, while believing that they are closely related, and but cyclic modifications of one original form, has found that convenience of study and a general clarity of comprehension warrants their separation under

four genera, in accordance with his well-known scheme of classification of the Uredinales in general.

There is justification in separating these forms into four species aside from their cyclic behavior, for each has small morphological features that show distinctive structural advance in addition to physiological habit. The aeciospores of *L. tucsonensis* are slightly smaller and thinner walled than in the other species, and the telia are large and at first blister-like, tending strongly to coalesce, instead of small and evenly scattered as in *P. fusca* and *T. punctata*, or somewhat circinating as in *T. cohaesa*, and have more mesospores than any one of these.

The vicinity of Tucson seems to be especially favorable for the appearance of the less usual cyclic development of various forms of rusts. It was within a few hundred yards of the Desert Botanical Laboratory that *Puccinia Carnegiana* and *P. tumamocensis*, the long and short cycle forms of a divergent rust on *Dipterostemon* (*Brodiaea*) were found and somewhat studied. The new rust on the upright euphorbias, recently discovered by Mr. E. Bethel, and described in this article, is evidently a product of similar environmental conditions. In fact the whole arid region of southern Arizona and California offer a remarkable field for the study of the cyclic development of the rusts. Not only the cyclic development but also the cytological features of the rusts, especially those displaying contracted cycles, greatly need investigation, and in no species more than in the one under discussion.

TELEUTOSPORA Arthur & Bisby, gen. nov.

In his paper on the short cycle *Uromyces* of the United States G. R. Bisby (Bot. Gaz. **69**: 213. 1920) has excluded *Uromyces hyalinus* Peck from this group, although the species had been made the type of the genus *Telospora* (Résult. Sci. Congr. Bot. Vienne 346. 1906), which was intended to include only short cycle species. In the Arthur Herbarium the sheets of *U. hyalinus*, which were studied by Bisby in preparing his paper, bear many notes signed by him. On June 20, 1916, he made a sectional drawing of pycnia from a specimen of Seym. & Earle, Econ. Fungi Suppl. *B5b*, with the note: "Pycnia are found associated with uredinia, sometimes with telia; teliospores often in uredinia."

The same situation was detected on the same day in a collection by C. F. Baker, from Fort Collins, Colorado, collected June 10, 1894, from which he drew the conclusion: "Apparently the condition is, that uredinia occur, later being often occupied by teliospores." Two days afterward in studying the same specimen he notes, that "separate uredinia occur, occupied only by urediniospores, found at the tips of the younger leaves." On June 21, 1916, he found pycnia associated with uredinia in a specimen of Ellis & Ev. Fungi Columb. *2187*, from Kansas. The association of pycnia with uredinia in other collections has later been verified by persons working upon material in the Arthur Herbarium, especially by H. R. Rosen the year following.

From the above showing the short cycle genus of ordinary *Uromyces* appearance, which was characterized in 1906 under the name *Telospora*, requires another name, and *Teleutospora* is therefore here proposed, with *Uromyces Rudbeckiae* Arth. & Holw. on *Rudbeckia laciniata*, as the type. This with two other American species should now be written as follows:

Teleutospora Rudbeckiae (Arth. & Holw.) Arth. & Bisby (*Uromyces Rudbeckiae* Arth. & Holw.; Arth. Bull. Iowa Agr. Coll. **1884**: 154. 1885).

Teleutospora Solidaginis (Niessl) Arth. & Bisby (*Uromyces Solidaginis* Niessl, Verh. Natur.-Ver. Brünn **10**: 163. 1872)

Teleutospora bauhiniicola Arth. & Bisby (*Uromyces bauhiniicola* Arth. Bot. Gaz. **39**: 389. 1905).

MICROPUCCINIA Rostrup

Some months ago Professor H. S. Jackson, while working with material in the Arthur Herbarium, discovered that the type species of the genus *Dasyspora*, *D. foveolata* Berk. & Curt., is not a short cycle form, as had been assumed, but possesses uredinia of a very remarkable appearance. This discovery will be duly set forth in a paper to be published by Professor Jackson after a time. Not long afterward he came across the genus *Micropuccinia* in Rostrup's excellent treatise on plant diseases, published in 1902, being duly characterized on page 266, with a number of species appended, the first being *Micropuccinia Ribis* (DC.) Rostr. This genus, if interpreted to include also those short cycle forms that

germinate immediately upon maturity, which Rostrup kept separate in his genus *Leptopuccinia* on page 268 of the same work, covers the ground intended by the writer for the short cycle genus set forth in his Vienna paper of 1906, and for which he unfortunately selected the untenable name *Dasyspora*. The following species, mentioned in the paper referred to, are here transferred to the genus *Micropuccinia*, the new combinations to be credited to Arthur and Jackson in each instance.

Micropuccinia Actinellae (Webb.) Arthur & Jackson, comb. nov. (*Puccinia Actinellae* Syd.); **M. Adoxae** (Hedw.) comb. nov. (*P. Adoxae* Hedw.); **M. Aegopodii** (Schum.) comb. nov. (*P. Aegopodii* Schum.); **M. alpina** (Fckl.) comb. nov. (*P. alpina* Fckl.); **M. andina** (Diet. & Neger) comb. nov. (*P. andina* Diet. & Neger, *P. Ranunculi* Seym.); **M. Anemones-virginianae** (Schw.) comb. nov. (*P. Anemones-virginianae* Schw.); **M. annularis** (Str.) comb. nov. (*P. annularis* Schlecht.); **M. Arenariae** (Schum.) comb. nov. (*P. Arenariae* Schröt., *P. Spergulae* DC.); **M. asarina** (Kunze) comb. nov. (*P. asarina* Kunze); **M. Asteris** (Duby) comb. nov. (*P. Asteris* Duby, *P. Erigerontis* E. & E., *P. Helenii* Schw.); **M. astrantiicola** (Bubák) comb. nov. (*P. astrantiicola* Bubák, *P. Astrantiae* Kalchbr. not B. & C.); **M. Betonicae** (A. & S.) comb. nov. (*P. Betonicae* DC.); **M. Buxi** (DC.) comb. nov. (*P. Buxi* DC.); **M. canadensis** (Arth.) comb. nov. (*P. canadensis* Arth.); **M. Chrysoplenii** (Grev.) comb. nov. (*P. Chrysoplenii* Grev.); **M. Circaeae** (Pers.) comb. nov. (*P. Circaeae* Pers.); **M. Cnici-oleracei** (Pers.) comb. nov. (*P. Cnici-oleracei* Pers.); **M. columbiensis** (E. & E.) comb. nov. (*P. columbiensis* E. & E., *P. bicolor* E. & E.); **M. Comandrae** (Peck) comb. nov. (*P. Comandrae* Peck); **M. concrescens** (E. & E.) comb. nov. (*P. concrescens* E. & E., *P. compacta* Kunze); **M. conferta** (D. & H.) comb. nov. (*P. conferta* D. & H.); **M. conglomerata** (Str.) comb. nov. (*P. conglomerata* Str.); **M. Cruciferarum** (Rud.) comb. nov. (*P. Cruciferarum* Rud.); **M. Cupheae** (Holw.) comb. nov. (*P. Cupheae* Holw., *P. jaliscensis* Holw.); **M. Dayi** (Clint.) comb. nov. (*P. Dayi* Clint.); **M. distorta** (Holw.) comb. nov. (*P. distorta* Holw.); **M. Drabae** (Rud.) comb. nov. (*P. Drabae* Rud.); **M. enormis** (Fckl.) comb. nov. (*P. enormis* Fckl.); **M. Epilobii** (DC.) comb. nov. (*P. Epilobii* DC.); **M. expansa** (Link) comb. nov.

(*P. expansa* Link); **M. Fergussoni** (Berk. & Br.) comb. nov. (*P. Fergussoni* Berk. & Br.); **M. Glechomatis** (DC.) comb. nov. (*P. Glechomatis* DC.); **M. Grindeliae** (Peck) comb. nov. (*P. Grindeliae* Peck); **M. grisea** (Str.) comb. nov. (*P. grisea* Wint.); **M. Haleniae** (A. & H.) comb. nov. (*P. Haleniae* A. & H.); **M. Heterisiae** (H. S. Jackson) comb. nov. (*P. Heterisiae* H. S. Jackson, *P. aspera* D. & H.); **M. heterospora** (B. & C.) comb. nov. (*P. heterospora* B. & C.); **M. Heucherae** (Schw.) comb. nov. (*P. Heucherae* Diet., *P. Saxifragae* Schl.); **M. Holboellii** (Hornem.) comb. nov. (*P. Holboeleii* Rostr., *P. palefaciens* D. & H.); **M. Huteri** (Syd.) comb. nov. (*P. Huteri* Syd.); **M. Imperatoriae** (Jacky) comb. nov. (*P. Imperatoriae* Jacky); **M. Jueliana** (Diet.) comb. nov. (*P. Jueliana* Diet.); **M. Lantanae** (Farl.) comb nov. (*P. Lantanae* Farl.); **M. lateritia** (B. & C.) comb. nov. (*P. lateritia* B. & C.); **M. Leveillei** (Mont.) comb. nov. (*P. Leveillei* Mont., *P. Geranii-silvatici* Karst.); **M. Lobeliae** (Gerard) comb. nov. (*P. Lobeliae* Gerard); **M. Malvacearum** (Bert.) comb. nov. (*P. Malvacearum* Bert.); **M. Mesneriana** (Thüm.) comb. nov. (*P. Mesneriana* Thüm.); **M. mesomajalis** (B. & C.) comb. nov. (*P. mesomajalis* B. & C.); **M. Millefolii** (Fckl.) comb. nov. (*P. Millefolii* Fckl.); **M. ornata** (A. & H.) comb. nov. (*P. ornata* A. & H.); **M. Parnassiae** (Arth.) comb. nov. (*P. Parnassiae* Arth.); **M. Pazschkei** (Diet.) comb. nov. (*P. Pazschkei* Diet.); **M. Polemonii** (D. & H.) comb. nov. (*P. Polemonii* D. & H.); **M. porphyrogenita** (Curt.) comb. nov. (*P. porphyrogenita* Curt., *P. acuminata* Peck); **M. praemorsa** (D. & H.) comb. nov. (*P. praemorsa* D. & H.); **M. Pulsatillae** (Kalchbr.) comb. nov. (*P. Pulsatillae* Kalchbr., *P. DeBaryana* Thüm.); **M. Pyrolae** (Cke.) comb. nov. (*P. Pyrolae* Cke.); **M. recedens** (Syd.) comb. nov. (*P. recedens* Cke.); **M. rubefaciens** (Johans.) comb. nov. (*P. rubefaciens* Johans.); **M. scandica** (Johans.) comb. nov. (*P. scandica* Johans.); **M. Seymeriae** (Burr.) comb. nov. (*P. Seymeriae* Burr.); **M. Sherardiana** (Körn.) comb. nov. (*P. Sherardiana* Körn.); **M. Silphii** (Schw.) comb. nov. (*P. Silphii* Schw.); **M. Solidaginis** (Peck) comb. nov. (*P. Solidaginis* Peck); **M. Spegazzinii** (DeT.) comb. nov. (*P. Spegazzinii* DeT., *P. australis* Speg.); **M. Suksdorfii** (E. & E.) comb. nov. (*P. Suksdorfii* E. & E.); **M. Synedrellae** (Henn.) comb. nov. (*P. Synedrellae* Henn.,

P. Emiliae Henn.); **M. tuberculans** (E. & E.) comb. nov. (*P. tuberculans* E. & E.); **M. turrita** (Arth.) comb. nov. (*P. turrita* Arth.); **M. uralensis** (Tranz.) comb. nov. (*P. uralensis* Tranz.); **M. variolans** (Hark.) comb. nov. (*P. variolans* Hark.); **M. Veronicarum** (DC.) comb. nov. (*P. Veronicarum* DC.); **M. verruca** (Thüm.) comb. nov. (*P. verruca* Thüm.); **M. Virgaureae** (DC.) comb. nov. (*P. Virgaureae* DC.); **M. Vossii** (Körn.) comb. nov. (*P. Vossii* Körn.); **M. Xanthii** (Schw.) comb. nov. (*P. Xanthii* Schw.); **M. Xylorrhizae** (Arth.) comb. nov. (*P. Xylorrhizae* Arth.).

There are two names under *Dasyspora* in the Vienna paper, *D. Adenostegiae* and *D. cinnamomea*, that are not transferred, as it has been found in the meantime that these rusts are probably not short cycle species. A number of the names in that paper appear in the above list as synonyms. In addition to this list of names from the Vienna paper the following species, which are entitled to be placed under *Micropuccinia* and credited to Arthur and Jackson, are for convenience here transferred.

Micropuccinia albulensis (Magn.) comb. nov. (*P. albulensis* Magn.); **M. Crytotaeniae** (Peck) comb. nov. (*P. Cryptotaeniae* Peck); **M. curtipes** (Howe) comb. nov. (*P. curtipes* Howe); **M. Hydrophylli** (P. & C.) comb. nov. (*P. Hydrophylli* P. & C.); **M. Hyssopi** (Schw.) comb. nov. (*P. Hyssopi* Schw.); **M. Ligustici** (E. & E.) comb. nov. (*P. Ligustici* E. & E.); **M. Linkii** (Klotzsch) comb. nov. (*P. Linkii* Klotzsch); **M. Lygodesmiae** (E. & E.) comb. nov. (*P. Lygodesmiae* E. & E.); **M. maculosa** (Schw.) comb. nov. (*P. maculosa* Schw.); **M. Mertensiae** (Peck) comb. nov. (*P. Mertensiae* Peck); **M. obliqua** (B. & C.) comb. nov. (*P. obliqua* B. & C., *P. Gonolobi* Rav.); **M. Physostegiae** (Peck & Clint.) comb. nov. (*P. Physostegiae* Peck & Clint.); **M. Ranunculi** (Blytt) comb. nov. (*P. Ranunculi* Blytt); **M. Waldsteiniae** (Curt.) comb. nov. (*P. Waldsteiniae* Curt.).

PURDUE UNIVERSITY,
LAFAYETTE, INDIANA

INDEX TO AMERICAN BOTANICAL LITERATURE

1910–1920

The aim of this Index is to include all current botanical literature written by Americans, published in America, or based upon American material; the word America being used in the broadest sense.

Reviews, and papers that relate exclusively to forestry, agriculture, horticulture, manufactured products of vegetable origin, or laboratory methods are not included, and no attempt is made to index the literature of bacteriology. An occasional exception is made in favor of some paper appearing in an American periodical which is devoted wholly to botany. Reprints are not mentioned unless they differ from the original in some important particular. If users of the Index will call the attention of the editor to errors or omissions, their kindness will be appreciated.

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Anderson, H. W. Diseases of Illinois fruits. Univ. Illinois Agr. Exp. Sta. Circ. 241: 3–155. *pl. 1–2 + f. 1–60.* Ap 1920.

Andrews, E. F. Habits and habitats of the North American resurrection fern. Torreya **20**: 91–96. 1920.
Polypodium polypodioides.

Bastin, S. L. Does cold kill plants? Sci. Amer. **123**: 427. 23 O 1920.

Benoist, R. Descriptions d'espèces nouvelles de Phanérogames. Bull. Mus. Hist. Nat. Paris 1920. 184–188. 1920.
Includes *Bathysa difformis* sp. nov., from French Guiana.

Berry, E. W. New specific name. Torreya **20**: 101. 1920.
Inga culebrana from the Panama Oligocene.

Blakeslee, A. F., Belling, J., & Farnham, M. E. Chromosomal duplication and Mendelian phenomena in *Datura* mutants. Science II. **52**: 388–390. 22 O 1920.

Bödeker, F. *Mamillaria hirsuta* Böd. spec. nov. Monatschr. Kakteenk. **29**: 130–132. N 1919 [Illust.].
From Mexico.

Bonar, L. Wilt of white clover, due to *Brachysporium Trifolii*. Phytopathology **10**: 435–441. *f. 1–3.* 25 O 1920.
Includes description of *Brachysporium Trifolii* Kauffman, sp. nov.

Bradshaw, R. V. Ayrshire rose in Washington. Am. Bot. **26**: 98. Au 1920.

Bradshaw, R. V. Wildflowers of the Oregon coast. Am. Bot. **26**: 84–87. Au 1920.

Brandes, E. W. Mosaic disease of corn. Jour. Agr. Research **19**: 517–521. *pl. 95–96.* 16 Au 1920.

Bresadola, G. Selecta mycologica. Ann. Mycol. **18**: 26–70. 1920.
Includes 2 new genera and 45 new species from America.

Britton, E. G. "Disappearing wild flowers." Torreya **20**: 101. 1920.

Britton, N. L., & Rose, J. N. The Cactaceae. Vol. II. Carnegie Inst. Wash. Publ. **248**^{2}: 1–239. *pl. 1–40* + *f. 1–305.* 9 S 1920.
Includes 19 new genera and 48 new species.

Brown, E. D. W. Apogamy in *Osmunda cinnamomea* and *O. Claytoniana.* Bull. Torrey Club **47**: 339–345. *f. 1–10.* 5 O 1920.

Brown, F. B. H. The silicious skeleton of tracheids and fibers. Bull. Torrey Club **47**: 407–424. *f. 1–5.* 20 O 1920.

Brown, J. S. Subcortical formation and abnormal development of stomata in etiolated shoots of *Opuntia Blakeana.* Bot. Gaz. **70**: 295–307. *pl. 27–30* + *f. 1.* 19 O 1920.

Burns, G. P. Tolerance of forest trees and its relation to forest succession. Jour. For. **18**: 610–615. O 1920.

Carleton, M. B. The soap nut tree. Am. For. **26**: 621. O 1920.

Cheyney, E. G. Preliminary investigation of *Ribes* as a controlling factor in the spread of white pine blister rust. Science II. **52**: 342–345. 8 O 1920.

Child, C. M., & Bellamy, A. W. Physiological isolation by low temperature in *Bryophyllum.* Bot. Gaz. **70**: 249–267. *f. 1–6.* 19 O 1920.

[Clute, W. N.] Cold deserts and dry deserts. Am. Bot. **26**: 97. Au 1920.

Clute, W. N. The desert trumpet flower. Am. Bot. **26**: 77–79. Au 1920.

Cockerell, T. D. A. A new form of *Stanleya.* Torreya **20**: 101, 102. 1920.
S. glauca latifolia, from Kansas.

Coker, W. C. *Azalea atlantica* Ashe and its variety *luteo-alba* n. var. Jour. Elisha Mitchell Sci. Soc. **36**: 97–99. *pl. 1, 7.* S 1920.

Coker, W. C., & Couch, J. N. A new species of *Achlya.* Jour. Elisha Mitchell Sci. Soc. **26**: 100, 101. S 1920.
Achlya Orion, from North Carolina.

Cribbs, J. E. Early stem anatomy of *Todea barbara.* Bot. Gaz. **70**: 294. *pl. 23–26.* 19 O 1920.

Earle, F. S. La extirpación del mosaico de la caña como medio de represión. Puerto Rico Dept. Agric. y Trab. Bol. 22: 1–19. Ja 1920.

Farr, W. K. Cell-division of the pollen-mother-cell of *Cobaea scandens alba*. Bull. Torrey Club **47**: 325–328. *pl. 14*. 5 O 1920.

Farwell, O. A. Notes on the Michigan flora II. Michigan Acad. Sci. Rept. **21**: 345–371. 1919.
Includes many new varieties, combinations and forms. 1919.

Figueroa, C. A. El matizado de la caña de azúcar y la producción de azúcar en Puerto Rico. Rev. Agric. Puerto Rico **5**: 25–31. 30 S 1920.

Forbes, C. N. Notes on *Marsilea villosa* Kaulf. Occ. Papers Bishop Mus. **7**: 47–49. *pl. 13–14*. 1920.

Forbes, C. N. New Hawaiian Plants. VII. Occ. Papers Bishop Mus. **7**: 33–39. *pl. 3–11*. 1920.
7 new species.

Forbes, C. N., & Munro, G. C. A new *Cyanea* from Lanai, Hawaii. Occ. Papers Bishop Mus. **7**: 43. *pl. 12*. 1920.

Gager, C. S. Heredity and evolution in plants. i–xiii + 1–265. Philadelphia. 1920.

Gassner, G. Beiträge zur Frage der Überwinterung und Verbreitung der Getreideroste im subtropischen Klima. Zeitschr. Pflanzenkr. **26**: 329–374. 16 S 1916.
Observations made in Uruguay.

Grier, N. M. Notes on comparative regeneration in *Elodea* and *Ceratophyllum*. Am. Bot. **26**: 80–84. Au 1920.

Harlan, H. V., & Hayes, H. K. Occurrence of the fixed intermediate, *Hordeum intermedium haxtoni*, in crosses between *H. vulgare pallidum* and *H. distichon palmella*. Jour. Agr. Research **19**: 575–591. *pl. 103–106*. 1 S 1920.

Harvey, R. B. Some enemies of the potato. Sci. Am. Mo. **2**: 120–122. *f. 1–9*. O 1920.

Hastings, G. T. The vegetation of a cinder field. Torreya **20**: 96–100. 1920.

Hayes, H. K. The inheritance of the length of internode in the rachis of the barley spike. U. S. Dept. Agr. Bull. 869: 1–26. *pl. 1–2*. 30 S 1920.

Hayes, H. K., Parker, J. H., & Kurtzweil, C. Genetics of rust resistance in crosses of varieties of *Triticum vulgare* with varieties of *T. durum* and *T. dicoccum*. Jour. Agr. Research **19**: 523–542. *pl. 97–102* 1 S 1920.

Hedrick, U. P. Manual of American grape-growing. i–viii + 1–458. New York. 1919.

Hillmann, J. Beiträge zur Systematik der Flechten. Ann. Myc. **18**: 1–25. 1920.

Hitchcock, A. S. Poaceae, in Standley, P. C., Trees and shrubs of Mexico. Contrib. U. S. Nat. Herb. **23**: 65–70. 1920.

Höhnel, F. Mykologische Fragmenti. Ann. Myc. **18**: 71–97. 1920.
Includes *Valseutypella* gen. nov., from North America.

Holbert, J. R., & Hoffer, G. N. Control of the root, stalk and ear rot diseases of corn. U. S. Dept. Agr. Farmers' Bull. 1176: 3–24. *f. 1–25*. S 1920.

Hubert, E. E. Observations on *Cytospora chrysosperma* in the northwest. Phytopathology **10**: 442–447. 25 O 1920.

Hutchinson, J. *Jeffersonia* and *Plagiorhegma*. Kew Bull. Misc. Inform. **1920**: 242–245. 1920.

Johnson, F. R. Forests in the sand hills. Am. For. **26**: 582–584. O 1920.

Jones, D. F. Sterility in animals and plants. Sci. Am. Mo. **2**: 117–119. O 1920.

Judd, C. S. The first algaroba tree in Hawaii. Am. For. **26**: 605, 606. O 1920.

Kilmer, F. B., & Smith, R. O. Belladonna cultivation in a practical way. Am. Jour. Pharm. **92**: 620–630. S 1920. [Illust.]

Kirby, R. S., & Thomas, H. E. The take-all disease of wheat in New York State. Science II. **52**: 368–369. 15 O 1920.

Knuth, R. Dioscoreaceae americanae novae. Notizbl. Bot. Gart. und Mus. Berlin-Dahlem **7**: 185–222. 28 D 1917.
New species in *Dioscorea* (92) and *Rajania* (11).

Knuth, R. Oxalidaceae americanae novae. Notizbl. Bot. Gart. und Mus. Berlin-Dahlem **7**: 289–318. 15 My 1919.
New American species in *Oxalis* (77) and *Biophytum* (4).

Kränzlin, F. Zwei neue und eine kritische Orchidacee. Notizbl. Bot. Gart. und Mus. Berlin-Dahlem **7**: 319–322. 15 My 1919.
Dikylikostigma, gen. nov., from Venezuela and *Vanilla Preussii*, sp. nov., from Guatemala.

Kränzlin, F. *Cyrtochilum* H. B. K. Notizbl. Bot. Gart. und Mus. Berlin-Dahlem **7**: 81–101. 15 My 1917.
Includes 3 new South American species and many new combinations.

Kräusel, R. Einige Bemerkungen zur Bestimmung fossiler Koniferen-Hölzer. Österr. Bot. Zeitschr. **67**: 127–135. 1918.

Kunkel, L. O. Further data on the orange-rusts of *Rubus*. Jour. Agr. Research **19**: 501–512. *pl. D* + *pl. 92–94*. 16 Au 1920.

Lakon, G. Abnormes Vorkommen von gefingerten Blättern bei *Acer negundo* L. Zeitschr. Pflanzenkr. **27**: 100–102. *f. 1–2*. 25 Ap 1917.

Lamson-Scribner, F. Parks and gardens of Buenos Aires. Nat. Hist. **20**: 305–311. My–Je 1920.

Langdon, La D. M. Stem anatomy of *Dioon spinulosum*. Bot. Gaz. **70**: 110–125. *pl. 15–17* + *f. 1–4*. 21 Au 1920.

Langdon, S. C., & Gailey, W. R. Carbon monoxide a respiration product of *Nereocystis Luetkeana*. Bot. Gaz. **70**: 230–239. *f. 1–3*. 15 S 1920.

La Rue, C. D. Isolating single spores. Bot. Gaz. **70**: 319–320. 19 O 1920.

Legrand, J. F. El *Paspalum dilatatum*. I. Revista Agric. Puerto Rico 5^1: 13–17. Jl 1920; II. 5^2: 8–13. Au 1920. [Illust.]

Legrand, J. F. Plantas útiles de Puerto Rico. Revista Agric. Puerto Rico 4^5: 5–10. 31 My 1920.

Lehman, S. C. *Penicillium spiculisporum*, a new ascogenous fungus. Mycologia **12**: 268–274. *pl. 19*. 1920.

Levine, M. The behavior of crown gall on the rubber tree (*Ficus elastica*). Proc. Soc. Exper. Biol. and Med. **17**: 157, 158. 1920.

Lloyd, C. G. Mycological notes. **63**: 945–984. My 1920.

Loesener, T. Über eine neue *Stromanthe*-Art. Notizbl. Bot. Gart. und Mus. Berlin-Dahlem **7**: 410–411. 15 My 1920.
Stromanthe humilis of tropical America.

Lumbard, L. H. Cleavers. Am. Bot. **26**: 95. Au 1920.

Mac Caughey, V. Hawaii's tapestry forests. Bot. Gaz. **70**: 137–147. *f. 1–6*. 21 Au 1920.

Mac Caughey, V. The Hawaiian olona. Science II **52**: 240–241. 10 S 1920.

Mac Dougal, D. T. Auxographic measurement of swelling of bicolloids and of plants. Bot. Gaz. **70**: 126–136. *f. 1, 2*. 21 Au 1920.

MacDougal, D. T., & Spoehr, H. A. Swelling of agar in solutions of amino acids and related compounds. Bot. Gaz. **70**: 268–278. *f. 1–6*. 19 O 1920.

Macmillan, H. G. A frost injury of potatoes. Phytopathology **10**: 423–424. *pl. 13*. 1920.

Maddox, R. S. A veteran giant of elms. Am. For. **26**: 611. O 1920.

Magness, J. R. Composition of gases in intercellular spaces of apples and potatoes. Bot. Gaz. **70**: 308–316. *f. 1.* 19 O 1920.

Matz, J. Gumming disease of sugar cane in Porto Rico. Phytopathology **10**: 429–430. *f. 1.* 1920.

Matz, J. La gomosis de la caña. Revista Agric. Puerto Rico **5**[1]: 24–26. Jl 1920. [Illust.]

Matz, J. La gomosis de la caña de azúcar. Puerto Rico Dept. Agric. y Trab. Circ. 20: 1–7. 1920. [1 plate.]

Matz, J. Pudrición de la base de la "roselle." Revista Agric. Puerto Rico **5**[1]: 18–20. Jl 1920. [Illust.]

Maxon, W. R. Gleicheniaceae and Cyatheaceae, in Standley, P. C., Trees and shrubs of Mexico. Contrib. U. S. Nat. Herb. **23**: 36–47. 1920.

McCool, M. M., & Millar, C. E. Use of dilatometer in studying soil and plant relationships. Bot. Gaz. **70**: 317–319. 19 O 1920.

McMurray, N. Color of *Aster* florets. Am. Bot. **26**: 107. Au 1920.

Mc Rae, W. A. Some principal fibre-bearing plants of Florida. Florida Agr. Dept. Bull. 30: 7–15. 1 Jl 1920.

Mez, C. Novae species Panicearum. Notizbl. Bot. Gart. und Mus. Berlin Dahlem **7**: 45–78. 15 My 1917.

New American species in *Olyra* (5), *Cenchrus* (1), *Pennisetum* (1), *Setariopsis* (1) and *Panicum* (15).

Moreau, F. A propos du nouveau genre *Kunkelia* Arthur. Bull. Soc. Mycol. France **36**: 101–103. 15 Jl 1920.

Morita, K., & Livingstone, B. E. Some solution cultures of wheat without potassium. Tokio Bot. Mag. **34**: 71–90. *f. 1.* Je 1920.

Moulton, R. H. Do plants need the dark? Gard. Mag. **32**: 98–99. O 1920. [Illust.]

Murphy, P. A., & Wortley, E. J. Relation of climate to the development and control of leaf roll of potato. Phytopathology **10**: 407–414. *f. 1.* 1920.

Murrill, W. A. A new *Amanita*. Mycologia **12**: 291–292. 1920.

Venenarius Wellsii sp. nov.

Murrill, W. A. Autobasidiomycetes, in Britton, N. L., The Bahama Flora 637–645. 26 Je 1920.

Nelson, A. Flora of the Navajo Reservation. Am. Bot. **26**: 87–89. Au 1920.

Nelson, J. C. Flower buds two years old. Am. Bot. **26**: 99. Au 1920.

Neuwirth, M. Vergleichende Morphologie der Trichome an der Blütenteilen der Cycadeen. Österr. Bot. Zeitschr. **66**: 141-149. *pl. 2.* 1916.

Norton, J. B. S., & Chen, C. C. Another corn seed parasite. Science II. **52**: 250–251. 10 S 1920.

Nowell, W., & Williams, C. B. Sugar cane blight in Trinidad: a summary of conclusions. Bull. Dept. Agr. Trinidad & Tobago **19**: 8–10. 1920.

Osburn, R. C. The syrphid fly, *Mesogramma marginata*, and the flowers of *Apocynum*. Ohio Jour. Sci. **20**: 261–265. *pl. 1.* 15 Jl 1920.

Parker, F. W., & Truog, E. The relation between the calcium and the nitrogen content of plants and the function of calcium. Soil Sci. **10**: 49–56. *f. 1.* Jl 1920.

Pearson, W. H. *Aplozia Pendletonii* Pearson, n. sp. Bryologist **23**: 50–52. *pl. 2.* 17 S 1920.

Pemberton, C. G. Living stumps of trees. Am. For. **26**: 614–616. O 1920.

Pennell, F. W. Scrophulariaceae of Colombia I. Proc. Acad. Nat. Sci. Philadelphia **1920**: 136–188. 4 O 1920.

Includes *Monocardia* and *Unanuea*, gen. nov., and new species in *Caconapea* (3) *Gratiola* (1), *Monocardia* (4), *Macuillamia* (1), *Alonsoa* (1), *Fagelia* (10), *Russelia* (1).

Pilger, R. Plantae Uleanae novae vel minus cognitae. Notizbl. Bt.o Gard. und Mus. Berlin-Dahlem **6**: 485–503. 15 Ja 1917.

Includes Piperaceae and Meliaceae by C. de Candolle, here indexed separately.

Pittier, H. La evolución de las ciencias naturales y las exploraciónes botanicas en Venezuela. Cultura Venezolana **14**: (Suppl.) 1–28. 1920.

Prankerd, T. L. Statocytes of the wheat haulm. Bot. Gaz. **70**: 148–152. *f. 1–4.* 21 Au 1920.

Quehl, L. *Echinocactus Rettigii* Quehl spec. nov. Monatschr. Kakteenk. **29**: 129. N 1919.

From Peru.

Reed, G. M. Varietal resistance and susceptibility of oats to powdery mildew, crown rust and smuts. Missouri Agr. Exp. Sta. Research Bull. 37: 3–41. *pl. 1–4.* Jl 1920.

Reed, H. S. The dynamics of a fluctuating growth rate. Proc. Nat. Acad. Sci. **6**: 397–410. 15 Jl 1920.

Growth of apricots studied.

Ricalton, J. The cocoa-nut palm. Am. Forestry **26**: 529–531. S 1920. [Illust.]

Rickett, H. W. Regeneration in *Sphaerocarpos Donnellii*. Bull. Torrey Club **47**: 347–357. *f. 1–25*. 5 O 1920.

Riddle, L. W. Lichens, in Britton, N. L., The Bahama Flora 522–553. 26 Je 1920.
Includes 19 new species.

Roberts, R. H. Off-year apple bearing and apple spur growth. Agr. Exp. Sta. Univ. Wisconsin Bull. 317: 3–34. *f. 1–13*. Jl 1920.

Robbins, W. J., & Massey, A. B. The effect of certain environmental conditions on the rate of destruction of vanillin by a soil bacterium. Soil. Sci. **10**: 237–246. *f. 1*. S 1920.

Rock, J. F. The leguminous plants of Hawaii. Honolulu, Hawaii. i–x + 1–234. Jl 1920.

Rolfe, R. A. *Pleurothallis grandis*. Bot. Mag. *pl. 8853*. S 1920.

Rosenbaum, J. A *Macrosporium* foot-rot of tomato. Phytopathology **10**: 415–422. *f. 1–4*. 1920.

Rumbold, C. Giving medicine to trees. Sci. Am. Mo. **2**: 114–116. O 1920.

Rusk, H. M. The effect of zinc sulphate on protoplasmic streaming. Bull. Torrey Club **47**: 425–431. *f. 1–2*. 20 O 1920.

Sando, C. E. The process of ripening in the tomato, considered especially from the commercial standpoint. U. S. Dept. Agr. Bull. 859: 1–38. *pl. 1–4* + *f. 1–3*. 7 S 1920.

Saunders, E. R. Multiple allelomorphs and limiting factors in the stock (*Matthiola incana*). Jour. Gen. **10**: 149–178. *pl. 7–8* + *f. 1–3*. 20 Au 1920.

Schlechter, R. Die Columelliaceae. Notizbl. Bot. Gart. und Mus. Berlin-Dahlem. **7**: 352–358. 15 Ja 1920.
Includes 2 new Andine species of *Columellia*.

Schlechter, R. Orchidaceae novae, in caldariis Horti Dahlemensais cultae. Notizbl. Bot. Gart. und Mus. Berlin-Dahlem **7**: 268–280. 1 O 1918; II. **7**: 323–330. 15 My 1919.
Includes American species of *Masdevallia* (1), *Stelis* (6), *Pleurothallis* (7), *Octomeria* (3), *Cryptophoranthus* (1), *Bulbophyllum* (1), *Promenaea* (2), *Capanema* (1) and *Oncidium* (1).

Schlechter, R. Über eine neue *Stanhopea*-Art. Notizbl. Bot. Gard. und Mus. Berlin-Dahlem **6**: 483–484. 15 Ja 1917.
Stanhopea minor from Brazil.

Schlechter, R. Versuch einer systematischen Neuordnung der Spiranthinae. Beih. Bot. Centralbl. **37**: 317–454. 31 Mr 1920.
Includes 15 new genera and 1 new species from America.

Schneider, C. Weitere Beiträge zur Kenntnis der chinesischen Arten der Gattung *Berberis* (*Euberberis*). Österr. Bot. Zeitschr. **66**: 313–326. 1916; **67**: 15–32. 1918; **67**: 135–146. 1918; **67**: 213–228. 1918; **67**: 284–300. 1918.

Schneider, C. Über die richtige Benennung einiger *Salix*-arten. Österr. Bot. Zeitschr. **66**: 112–116. 1916.

Schneider, C. Beiträge zur Kenntnis der Gattung *Ulmus*. II. Über die richtige Benennung der europäischen Ulmen-Arten. Österr. Bot. Zeitschr. **66**: 65–82. 1916.

Seaver, F. J. Fungi, in Britton, N. L., The Bahama Flora 631–645. 26 Je 1920.
Includes 5 new species.

Shelford, J. E. Our aquatic biological resources. Geog. Rev. **9**: 250–263. Ap–Je 1920.

Small, J. K. In quest of lost cacti. Cactus hunting in the Carolinas in winter. Jour. New York Bot. Gard. **21**: 161–178. *pl. 251, 252.* S 1920.

Smith, A. A lesson on the production of available plant food in the soil. Gard. Chron. **24**: 312–314. S 1920.

Solereder, H. Uber die Versetzung der Gattung *Heteranthia* von den Scrophulariaceen zu den Solanaceen. Beih. Bot. Centralbl. **33**^{2}: 113–117. 10 F 1915.

Sprague, T. A. *Nuphar polysepalum*. Bot. Mag. *pl. 8852.* S 1920.

Standley, P. C. Trees and shrubs of Mexico. (Gleicheniaceae-Betulaceae). Contrib. U. S. Nat. Herb. **23**: i–xviii + 1–169. 1920.
Includes contributions by W. R. Maxon, A. S. Hitchcock and W. Trelease, here indexed separately. 31 new species of *Agave* are described.

Stillinger, C. R. Apple black rot (*Sphaeropsis malorum* Berk.) in Oregon. Phytopathology **10**: 453–458. 25 O 1920.

Sydow, H. & P. Über einige Uredineen mit quellbaren Membranen und erhöhter Keimporenzahl. Ann. Myc. **17**: 101–107. 1919.

Täckholm, G. Zur Antipodenentwicklung der Kompositengattungen *Cosmidium* und *Cosmos*. Sv. Bot. Tidskr. **10**: 423–437. *f. 1–4.* 1916.

Täckholm, G., & Söderberg, E. Neue Beispiele der simultanen und sukzessiven Wandbildung in den Pollenmutterzellen. Sv. Bot. Tidskr. **12**: 189–201. *f. 1–9.* 1920.

Tansley, A. G. The classification of vegetation and the concept of development. Jour. Ecol. **8**: 118–149. Je 1920.

Taylor, A. M. Ecological succession of mosses. Bot. Gaz. **69**: 449–491. *f. 1, 2.* 17 Je 1920.

Taylor, N. A rare palm from Cuba in the conservatories. Brooklyn Bot. Gard. Rec. **9**: 101, 102. Jl 1920.

Coccothrinax crinita.

Taylor, W. R. On the production of new cell formations in plants. Contr. Bot. Lab. Univ. Pennsylvania **4**: 271–300. *pl. 71–78.* 1920.

Thiel, A. F., & Weiss, F. The effect of citric acid on the germination of the teliospores of *Puccinia graminis Tritici.* Phytopathology **10**: 448–452. *f. 1.* 25 O 1920.

Thompson, C. A., & Barrows, E. L. Soil moisture movement in relation to growth of alfalfa. New Mexico Coll. A. & M. Arts Bull. 123: 1–38. F 1920.

Toepffer, A. Nordasiatische und nordamerikanische Weiden (*Salix*) Gallen. Beih. Bot. Centralbl. **37**: 279–287. 20 F 1920.

Trelease, W. Amaryllidaceae, in Standley, P. C. Trees and shrubs of Mexico. Contrib. U. S. Nat. Herb. **23**: 105–142. 1920.

Includes 31 new species of *Agave.*

Ulbrich, E. Einige neue *Lupinus*-Arten aus den Anden von Peru. Notizbl. Bot. Gart. und Mus. Berlin-Dahlem **7**: 452–454. 16 My 1920.

3 species described.

Ulbrich, E. Eine neue *Sedum*-Art aus dem botanischen Garten in Dahlem. Notizbl. Bot. Gart. und Mus. Berlin-Dahlem **7**: 111, 112. 15 My 1917.

Sedum aoikon, probably from Mexico.

Uphof, J. C. T. Physiological anatomy of xerophytic selaginellas. New Phytol. **19**: 101–131. *f. 1–12.* 10 Jl 1920.

Vaupel, F. *Echinocactus Ottonis* Lk. et Otto. Monatschr. Kakteenk. **29**: 124. N 1920. [Illust.]

Vaupel, F. *Melocactus hispaniolicus* Vpl. spec. nov. Monatschr. Kakteenk. **29**: 121. N 1919.

From Hispaniola.

Vischer, W. Sur les *Quaraibea* Aubl. un genre de Bombacées a ovaire infère. Bull. Soc. Bot. Genève **11**: 199–210. *f. 1–5.* 15 Je 1920.

Includes *Q. Chodati* sp. nov. from Costa Rica.

Wagner, R. Erlaüterungen zu Plumiers Abbildung der *Anechites lappulacea* (Lam.) Miers. Österr. Bot. Zeitschr. **67**: 337–345. *f. 1–3.* 1918.

Wakefield, E. M. On two species of *Oulariopsis* from the West Indies. Kew Bull. Misc. Inform. **1920**: 235–238. 1920.
Two new species.

Waldron, R. A. The peanut (*Arachis hypogaea*)—its history, histology, physiology and utility. Contr. Bot. Lab. Univ. Pennsylvania **4**: 301–338. *pl. 79, 80.* 1920.

Walker, L. B. Developments of *Cyathus fasciculatis*, *C. striatus* and *Crucibulum vulgare*. Bot. Gaz. **70**: 1–24. *pl. 6* + *f. 1–3.* 24 Jl 1920.

Watson, E. E. *Corylus rostrata*. Addisonia **5**: 25, 26. *pl. 173.* 30 Je 1920.

Weatherwax, P. A misconception as to the structure of the ear of maize. Bull. Torrey Club **47**: 359–362. *f. 1–6.* 5 O 1920.

Weatherby, C. A. A European primrose in New England. Rhodora **22**: 143. 23 S 1920.
Primula officinalis in Connecticut.

Weatherby, C. A. More interesting fern localities. Amer. Fern Jour. **10**: 57–59. 29 Je 1920.

Weatherby, C. A. Varieties of *Pityrogramma triangularis*. Rhodora **22**: 113–120. 3 Au 1920.
Two new varieties.

Weidman, R. H. A study of windfall loss of western yellow pine in selection cuttings fifteen to thirty years old. Jour. For. **18**: 616–622. O 1920.

Weingart, W. *Cereus Jusbertii* Rev. und *Cereus Bonplandii* Parm. var. *brevispinus* Gruson. Monatschr. Kakteenk. **29**: 121–124. N 1919.

Weingart, W. Die Grösse von Cereensamen. Monatschr. Kakteenk. **29**: 132. N 1919.

Weir, J. R. Note on the pathological effects of blazing trees. Phytopathology **10**: 371–373. 18 Au 1920.

Weiss, H. B., & West, E. Fungous insects and their hosts. Proc. Biol. Soc. Wash. **33**: 1–19. *pl. 1.* 24 Jl 1920.

Wells, B. W. Early stages in the development of certain *Pachypsylla* galls on *Celtis*. Am. Jour. Bot. **7**: 275–285. *pl. 18.* 6 Au 1920.

Wherry, E. T. Observations on the soil acidity of Ericaceae and associated plants in the Middle Atlantic States. Proc. Acad. Nat. Sci. Philadelphia **72**: 84–119. Je 1920.

Wherry, E. T. Plant distribution around salt marshes in relation to soil acidity. Ecology **1**: 42–48. Ja 1920.

Wherry, E. T. A fruitless search for *Asplenium fontanum* in Pennsylvania. Am. Fern Jour. **10**: 90–91. 1920.

Whipple, O. B. Line-selection work with potatoes. Jour. Agr. Research **19**: 543–573. 1 S 1920.

Whiting, A. L., & Hansen, R. Cross-inoculation studies with nodule bacteria of lima beans, navy beans, cowpeas, and others of the cowpea group. Soil Sci. **10**: 291–300. O 1920.

Willaman, J. J. Pectin relations of *Sclerotinia cinerea*. Bot. Gaz. **70**: 221–229. 15 S 1920.

Williams, R. S. *Grimmia* (*Guembelia*) *brevirostris*, sp. nov. Bryologist **23**: 52, 53. *pl. 3*. 17 S 1920.

Williams, R. S. Calymperaceae of North America. Bull. Torrey Club **47**: 367–396. *pl. 15–17*. 20 O 1920.
Includes 4 new species.

Wilson, E. H. A phytogeographical sketch of the ligneous vegetation of the flora of Formosa. Jour. Arnold Arbor. **2**: 25–41. 1920.

Wilson, I. K. Device for growing large plants in sterile media. Phytopathology **10**: 425–429. *f. 1*. 1920.

Wilson, O. T. Crown-gall of alfalfa. Bot. Gaz. **70**: 51–68. *pl. 7–10*. 24 Jl 1920.

Winslow, C. E. A., Broadhurst, J., & others. The families and genera of the bacteria. Jour. Bacter. **5**: 191–229. My 1920.

Winslow, E. J. The Dorset fern list again. Am. Fern Jour. **10**: 59, 60. 29 Je 1920.

Wolf, F. A. A little-known vetch disease. Jour. Elisha Mitchell Sci. Soc. **36**: 72–85. *pl. 2–6*. S 1920.
Caused by *Protocoronospora nigricans* Atk. & Edg., of the Melanconiaceae.

Wright, R. C. Nitrogen economy in the soil as influenced by various crops grown under control conditions. Soil Sci. **10**: 249–289. *f. 1–9*. O 1920.

Yates, W. Natural history notes. Jour. and Proc. Hamilton Assoc. Sci. **25, 26**: 122–124. 1910.
Notes on *Onoclea* and *Sambucus*.

Youngken, H. W. The comparative morphology, taxonomy and distribution of the Myricaceae of the eastern United States. Contr. Bot. Lab. Univ. Pennsylvania **4**: 339–400. *pl. 81–90*. 1920.
Includes *M. Macfarlanei* Youngken, a new hybrid.

Zeller, S. M. Humidity in relation to moisture imbibition by wood and to spore germination on wood. Ann. Missouri Bot. Gard. **7**: 51–73. *pl. 1*. F 1920.

Zon, R. Forests and human progress. Geog. Rev. **9**: 139–166. S 1920.

Zundel, G. L. Some Ustilagineae of the state of Washington. Mycologia **12**: 275–281. 1920.

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BULLETIN

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Contributions to the Mesozoic flora of the Atlantic coastal plain, XIV.—Tennessee*

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In the eleventh contribution of this series, published in 1916,† an account was given of small floras found in the Coffee sand and McNairy sand of the west Tennessee coastal plain. Fourteen species were recorded from the former and twelve from the latter, both florules confessedly too limited to give any idea of their general facies or stratigraphic equivalence. During the summer of 1919 Dr. Bruce Wade of the Tennessee Geological Survey discovered abundant and better preserved material at several localities in the Eutaw and Ripley formations. These collections have now been identified and furnish for the first time the basis for a truer estimate of this youngest known Cretaceous flora of the Mississippi embayment region and an opportunity for comparisons with the fossil floras of other areas.

The time relations of the various members of the Upper Cretaceous section in this area are shown in the accompanying diagram. The Tuscaloosa formation which has furnished an extensive flora recently monographed by the writer‡ comprises essentially continental and largely delta deposits contemporaneous with the basal estuary and marine beds of the Eutaw formation.

[The BULLETIN for January (48: 1–54) was issued January 24, 1921.]

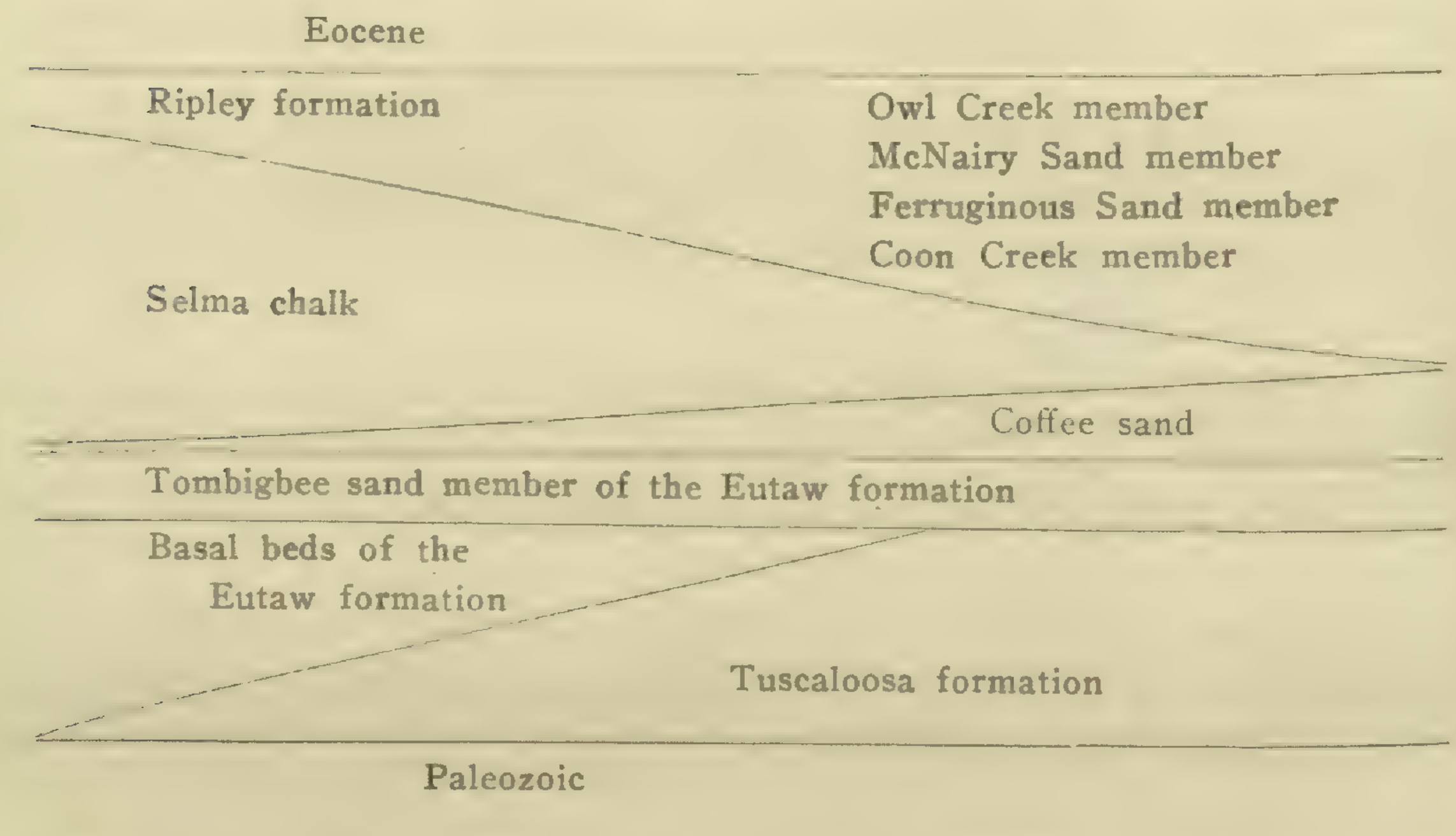
* The last previous contribution of this series appeared in Bull. Torrey Club 47: 397–406. 1920.

† Bull. Torrey Club 43: 283–304. *pl. 16.* 1916.

‡ U. S. Geol. Surv., Professional Paper 112. 1919.

The Tombigbee sand member of the Eutaw formation represents transgressive marine deposits without land plants but with a marine fauna. To the southward the Tombigbee is overlain by the Selma chalk—a lithologic and not a chronologic unit. In western Tennessee the time interval corresponding to the lower Selma chalk is represented by the Coffee sand member of the Eutaw formation which at a few localities in Tennessee contains a considerable number of fossil plants. The Coffee sand in Tennessee is overlain by a calcareous clay representing a thin tongue from the thick mass of Selma chalk to the south. Overlying the Selma in the Tennessee area, the Ripley formation is differentiated into four members to which the names Coon Creek, Ferruginous Sand, McNairy Sand and Owl Creek have been applied. All of these are littoral or marine deposits with in some cases abundant marine faunas.

All but thirteen of the 135 species of fossil plants recorded from the Ripley formation in the following pages come from



shallow water lenses of plastic clay in the McNairy sand member. These clay lenses represent accumulations of fine material in estuary or coastal lagoon waters with a well forested shore near at hand. The accompanying diagram shows the stratigraphic units and their general relations in the Mississippi embayment region.

FLORA OF THE EUTAW FORMATION

The Eutaw flora is still incompletely known. The Eutaw sediments, in so far as they might preserve land plants successfully, are either marine clays or littoral, prevailingly sandy, deposits. The former contain only decay-resisting forms, such as *Araucaria* twigs and coriaceous dicotyledons, and the latter similar forms that successfully withstood the triturating action of troubled waters, since as yet no clay lenses with any extensive representation of plants that grew along the Eutaw shores have been discovered. The Eutaw flora, which has been collected chiefly from the Chattahoochee valley in Georgia, from near Havana in Hale County, Alabama, and from near Beacon in Decatur County and at Coffee Bluff in Tennessee, consists of but forty-six species. It includes no ferns, thirty-four angiosperms and eleven gymnosperms. Among the latter are the genera *Androvettia*, *Brachyphyllum*, *Cephalotaxospermum*, *Cupressinoxylon*, *Sequoia* and *Tumion*, which are unknown in the Ripley, as well as the twigs and scales of *Araucaria* which, although recorded from the Ripley, come from deposits of the same age as the Eutaw in other regions. These are preserved in the Eutaw because of their resistance to maceration but should be present in the Ripley if they had not become extinct.

Similarly among the dicotyledons the prevailing forms found in the Eutaw are coriaceous types, such as *Andromeda*, *Cinnamomum*, *Ficus*, *Magnolia*, *Myrcia*, *Manihotites*, *Sabalites* and the like. Following is a list of the known Eutaw species, those marked with an asterisk being also present in the Ripley. Sixteen of the Eutaw species continue into the Ripley, but the following genera of the Eutaw have not been recognized in the Ripley: *Androvettia*, *Brachyphyllum*, *Cephalotaxospermum*, *Cupressinoxylon*, *Dewalquea*, *Diospyros*, *Paliurus*, *Pterospermites*, *Sequoia* and *Tumion*.

Andromeda cretacea Lesquereux? (Ga.)
Andromeda novae-caesareae Hollick
Andromeda Parlatorii Heer (Ala.)
Andromeda Wardiana Lesquereux (Ga., Tenn.)
Androvettia elegans Berry (Ga.)
Aralia eutawensis Berry (Ga.)
Araucaria bladensis Berry (Ga.)*

Araucaria Jeffreyi Berry (Ga.)*
Bauhinia alabamensis Berry (Ala.)
Brachyphyllum macrocarpum formosum Berry (Ga.)
Cephalotaxospermum carolinianum Berry (Ala.)
Cinnamomum Heerii Lesquereux? (Ga., Tenn.)
Cinnamomum Newberryi Berry (Ga.)*
Cupressinoxylon sp. Berry (Tenn.)
Dewalquea Smithii Berry (Tenn.)
Diospyros primaeva Heer (Tenn.)
Doryanthites cretacea Berry (Ala.)
Ficus crassipes (Heer) Heer (Ga., Tenn.)*
Ficus Krausiana Heer (Ga., Tenn.)*
Ficus ovatifolia Berry (Ga., Tenn.)
Geonomites Schimperi Lesquereux (Tenn.)*
Halymenites major Lesquereux (Tenn.)*
Juglans arctica Heer (Ga.)
Laurophyllum elegans Hollick (Tenn.)
Laurus plutonia Heer (Ala.)
Magnolia Boulayana Lesquereux (Ala., Ga.)
Magnolia Capellinii Heer (Ga.)*
Malapoenna horrellensis Berry (Ga., Tenn.)*
Manihotites georgiana Berry (Ga., Tenn.)*
Menispermites variabilis Berry (Ga.)*
Myrcia havanensis Berry (Ala., Tenn.)*
Myrtophyllum angusta Velenovsky (Ga.)*
Paliurus upatoiensis Berry (Ga.)
Phragmites Prattii Berry (Ga., Tenn.)
Phyllites asplenioides Berry
Pterospermites carolinensis Berry (Tenn.)
Sabalites carolinensis Berry (Tenn.)
Salix eutawensis Berry (Ga., Tenn.)
Salix flexuosa Newberry (Ga.)
Salix Lesquereuxii Berry (Ga.)
Sequoia ambigua Heer (Ala.)
Sequoia Reichenbachi (Geinitz) Heer (Ala., Ga.)
Ternstroemites sp. nov. (Tenn.)*
Tumion carolinianum Berry? (Ga.)
Zizyphus laurifolius Berry (Ga.)*

Plants which come up into the Ripley from pre-Eutaw horizons and therefore legitimately to be considered as probable unknown members of the Eutaw flora are:

Widdringtonites Reichii (Ettings.) Heer
Moriconia cyclotoxon Debey & Ettings.
Moriconia americana Berry
Myrica Brittoniana Berry
Leguminosites canavalioides Berry

FLORA OF THE RIPLEY FORMATION

Determinable fossil plants have been found at thirteen different localities that are referred to the Ripley formation. The localities in Alabama and Georgia which were described recently* furnish but few and on the whole not well-preserved fossil plants. They are separated by some 350 miles of coast line of the Ripley Sea from the southernmost locality for Ripley plants in Tennessee and this in turn is about 100 miles south of the highly fossiliferous localities in Henry and Carroll Counties. The other Tennessee localities are much like those of Alabama and Georgia as regards the character of the remains and their condition of preservation. It is at the Perry Place in Henry County and the Cooper Pit in Carroll County that most of the information regarding the Ripley flora has been collected.

Curiously enough each of these localities has yielded a total of sixty-six different species, and still more interesting is the fact that of this relatively large number there are only fifteen species common to both localities, or slightly under 13 per cent. of the total number of 117 species represented at the two localities. This differences of facies is not only a difference in species but in genera. For example at the Perry Place locality there are present the genera *Dioscorites*, *Geonomites*, *Protophyllocladus*, *Juglans*, *Salix*, *Liriodendron*, *Menispermites*, *Capparis*, *Acaciaphyllum*, *Caesalpinites*, *Dalbergia*, *Pachystima* (?), *Rhamnus*, *Cissites* and *Bumelia*, that are not found at the Cooper Pit, and the latter locality has furnished representatives of the genera *Selaginella*, *Asplenium*, *Monheimia*, *Widdringtonites*, *Geinitzia*, *Potamogeton*, *Alismaphyllum*, *Dryophyllum*, *Fagus*, *Celtis*, *Cedrela*, *Acer*,

* U. S. Geol. Surv. Professional Paper 112. 1919.

Dillenites, *Cinnamomum*, *Nectandra*, *Myrcia*, *Eugenia* (?), *Cornophyllum*, *Chrysophyllum* and *Acerates*, which have not been found at the Perry Place. Farther than this among the larger genera, *Myrica* with eleven species has only one common to the two localities, only two of the Leguminosae are common to both localities, of the seven species of *Celastrophyllum* there is but one species found at both outcrops, of the nine figs none are common to both, of the five species of *Apocynophyllum* none are common, of the three species of *Zizyphus* only one is common and that one is rare at one locality and abundant at the other; similarly of the three species of *Ternstroemites* only one is found at both localities.

Since these two horizons have been shown by the mapping to practically coincide these marked differences in apparent facies can be due to but two causes. That is they are to be accounted for solely as the result of accidents of preservation or discovery or as due to local differences in environmental conditions at the time of growth. Possibly a combination of these two is the correct solution. I am inclined, however, to think that in this as in many other cases of fossil floras and faunas, accidents of preservation and discovery are the major factors, and this emphasizes anew the extreme danger of relying upon negative evidence, since did we not know otherwise we should doubt the contemporaneity of these two florules.

All of the remaining localities where Ripley plants have been discovered have yielded too few species to afford satisfactory evidence for close correlation. Those in Tennessee are known to be of approximately identical age as the Perry Place and Cooper Pit from their stratigraphic position. Those in Barbour County, Alabama are undoubtedly Ripley but whether younger or older than the Tennessee floras cannot be determined. The two plant-bearing localities in Georgia wh'ch L. W. Stephenson has referred to the Cusseta sand member or lower Ripley of the Georgia area are of especial interest since they are the same age as the Coffee sand of Tennessee.

The localities of Henry and Carroll Counties, Tennessee, are well toward the head of the Cretaceous Mississippi embayment and over three degrees north of the localities in Barbour County, Alabama or of the Ripley localities in Georgia. Moreover it is

becoming increasingly clear that a large body of Upper Cretaceous deposits across Tennessee and Kentucky has disappeared during the formation of the Tennessee valley, so that in Selma and Ripley time the shoreline was some distance to the east of the present outcrop of these deposits and there was a considerable re-entrant or bay extending eastward from the head of the late Cretaceous Mississippi Gulf.

These relatively slight geographical changes are not believed to show any reflection in the facies of the flora, nor is it believed that their position with relation to the Atlantic or their difference in latitude would have an appreciable effect, since the corresponding floras extend over many degrees of latitude without appreciable changes as is also true of the contemporaneous marine faunas. The few Ripley plants previously recorded were coriaceous decay-resisting forms that might have been transported for considerable distances, but those from Henry and Carroll Counties present every indication of having lived in the vicinity where they were preserved. Their state of preservation indicates this as well as the abundance of small delicate and long slender forms. There could have been no wave action where these fine-grained clay lenses were deposited so that the clay owes its origin to the settling from suspension of muds either in a sheltered lagoon along the coast or in a quiet estuary or bayou of a slow moving stream. The clay is not black and carbonaceous in so far as it is exposed, but the thickness seen is inconsiderable and immediately below the upper contact with the sands so that nothing is known of the character of the lower clay.

The sands are coarse beach and barrier beach sands and the clay lenses tend to have their long axis approximately parallel to the old coast line. In general character the relations are very similar to those which obtain during the lower Eocene in this same region. This argillaceous horizon is a rather persistent one, consisting of disconnected lenses of greater or less extent which extend in a north and south direction for a distance of at least 50 miles across Henry and Carroll Counties. Farther north in Henry County there is a considerable bed of lignite upwards of 20 inches thick exposed, but none is seen near the plant-bearing outcrops nor is the base of the clay exposed.

The conditions may be pictured as a series of coastal lagoons stretching along the shore of the Ripley Sea from which they were partially or wholly cut off by barrier beaches. Those less sheltered were filled with the argillaceous sands such as occur west of Camden, Tennessee, and farther south, where most of the plant fragments were broken up, and the more or less carbonaceous clays contain identifiable fragments of only the more resistant types. The lagoons represented by the Perry and Cooper localities were more sheltered and protected from wave action, at least for long intervals, during which the fine muds were deposited. That there were no considerable streams emptying into the Ripley Sea in the Tennessee region is rendered very probable by the history of the Tennessee River lying to the eastward. The Tennessee appears to have been the master stream at that time, following much the same course that it does at the present time but farther to the eastward, its distributaries having migrated northward during Tuscaloosa time, as I have indicated in the discussion of Tuscaloosa history in 1919 (*op. cit.*). The Ripley mainland appears to have been well wooded. There is no evidence of distinctively palustrine conditions at the two principal plant localities, although elsewhere at this time such evidence is present. There are, however, several supposed aquatic plants present in the collection, and the number of coastal types is considerable.

The Ripley flora as at present known comprises 135 species, including the doubtfully organic remains named *Halymenites*. Most of these species are represented by well preserved and ample material and are hence well characterized. Undoubtedly more extensive collecting would greatly increase the number of species and this is also to be expected should similar highly fossiliferous clay lenses be uncovered in the future. Eighty-six of the 135 species, or more than 60 per cent, are new to science and these include the following genera hitherto unknown in deposits older than the Eocene: *Dioscorites*, *Celtis*, *Capparis*, *Cedrela*, *Dillenites* and *Chrysophyllum*.

The total number of genera is seventy-one and these are segregated into forty families representing twenty-eight orders. The supposed alga, *Halymenites*, and the form referred to the genus *Selaginella* are of doubtful botanic affinity. There are

represented very fragmentary remains of six different species of ferns. These are all small and of more or less doubtful botanical identity but of importance for purposes of correlation since nearly all are found in other areas, especially in Greenland and Europe. There are nine species of gymnosperms, but several of these are of somewhat doubtful age value and traces of plants of this affinity are extremely rare in western Tennessee.

The monocotyledons also number nine species, including a fan palm, and a feather palm which is referred to the genus *Geonomites* and is a type that is prominent in the lower Eocene of the Raton Mesa region. Several of the monocots appear to represent aquatic or semi-aquatic species. Thus there is a well marked *Potamogeton* and the mudflat type *Alismaphyllum*. In addition the forms named *Phyllites hydrilloides* and *Phyllites hydrocharitoides* appear to represent aquatics. The former shows great resemblance to *Hydrilla* of the family Hydrocharitaceae, a genus supposed to be monotypic in the existing flora and widely distributed throughout the Old World. The second appears to represent an Upper Cretaceous type of this same family comparable in its habit with the existing genus *Vallisneria*.

The dicotyledons of the Ripley flora number one hundred eight of which ninety-seven belong to the more primitive or choripetalous series and only eleven represent the more specialized Gamopetalae. Among the Choripetalae the anemophilous forms, regarded as primitive by some botanists and reduced by others, number nineteen. The largest alliance is the Rosales with fourteen species, all of which belong to the Leguminosae. Since these represent the three families Mimosaceae, Caesalpiniaceae and Papilionaceae no one is more extensive than another or compares in size with some of the other families present at this time.

The second largest family is the Lauraceae with twelve species, but my recognition of minute differences in the genera *Cinnamomum* and *Laurus* tends to overemphasize their relative importance in the Ripley flora. The family Myricaceae is third in size with eleven species, all of which belong to the genus *Myrica*, which shows an extraordinary differentiation at this time. The next most abundantly represented family is the Moraceae with ten species, nine of which are referred to *Ficus* and the tenth to a

striking new form of *Artocarpus*. None of the species of *Ficus* are individually abundant in the collections. Then follows the family Celastraceae with seven species. The family Apocynaceae has five species all of which are referred to the genus *Apocynophyllum*. The Euphorbiaceae, Rhamnaceae and Myrtaceae have four species each; and the Juglandaceae, Fagaceae, Ternstroemaceae and Sapotaceae have three species each. The remaining families have only one or two species. The largest single genera are *Myrica* with eleven, *Ficus* with nine, and *Celastrophyllum* with six species. If the type represented by *Celastrophyllum* were combined with the forms which I refer to *Ternstroemites* but which were formerly referred to *Celastrophyllum* it would constitute the most abundant type in both differentiation and individual abundance.

Among the one hundred five species of dicotyledons of the Ripley flora sixty-eight have entire margins. This is 64.7 per cent of the known forms. The ratio of entire dicotyledons leaves to the whole flora of woody dicotyledons has been shown by Bailey and Sinnott* to have a fairly constant relation to climatic conditions and altitude. According to the figures compiled by these authors subtropical and tropical lowland floras have over 70 per cent of their woody dicotyledons with entire leaves. Their published percentages range from 71 per cent in the flora of Hong Kong to 86 per cent in the flora of the Malay States. In making comparisons with fossil floras one is always confronted with the incompleteness of the record although, on the other hand, the vast majority of fossil forms are arborescent, thus removing one disturbing factor. The Ripley flora is obviously a lowland coastal flora so that the question of altitude is eliminated. It would thus appear that the percentage of entire leaves accords well with the conclusions derived from the general facies of the flora and that the climate was probably warm temperate, rather uniform and with an abundant precipitation.

It is interesting to see in this Ripley flora a characteristic local facies and this is especially the case, as might have been expected, among the dicotyledons. Nearly all of the ferns and all of the conifers have an outside distribution as befits their more

* Bailey, I. W., & Sinnott, E. W. Science II. **41**: 832–833. 1915.

ancient lineage and earlier radiation, and only thirty-three, or about 28 per cent, of the angiosperms have been found in other areas. This is still more striking than appears from the bare statement, for if Greenland be excluded as near the probable place of origin of the Upper Cretaceous floras, or at least the ancient home of those of eastern North America, it is seen that only six of the angiosperms are common to distant regions such as Europe. These six are *Dryophyllum gracile*, *Ficus Krausiana*, *Magnolia Capellini*, *Euphorbiophyllum antiquum*, *Cissites crispus* and *Myrtophyllum angustum*.

The Ripley flora shows a marked relationship to that of the antecedent Eutaw formation of this same region, to the Black Creek flora of the Carolinas and to the Magothy flora of New Jersey and Maryland. This is all the more remarkable in the case of the first two when it is realized how small and fragmentary are the known floras of the Eutaw and Black Creek. Thus sixteen of the Ripley species are common to the Eutaw, nineteen to the Black Creek and fifteen to the Magothy. The older Tuscaloosa flora of the eastern Gulf area has but six species which continue on into the Ripley and these are all widely distributed types all being common to either Greenland or Europe. It would appear that the Ripley flora consists of some few forms resident in this region since Tuscaloosa times, with many new elements which were added by immigration or evolution in the interval between the Tuscaloosa and Ripley.

In so far as the present records permit a conclusion the Ripley flora may be regarded as the culmination of the earlier Cretaceous floras of eastern North America. Certain of its species are only Ripley species because of the somewhat inconsistent usage of the formational name Ripley by geologists. Thus *Araucaria bladenensis* and *Araucaria Jeffreyi* which are so highly characteristic of the Black Creek and Eutaw formations are recorded from the Ripley formation of Georgia. They have never been found in the true Ripley of Alabama, Mississippi or Tennessee, and as I have shown elsewhere the Ripley Cusseta sand of Georgia is of the same age as the Eutaw Coffee sand of Tennessee.

There is a considerable number of forms common to the Patoot beds of Greenland. Thus eight of the Patoot species are found in

the Ripley and the general facies is more similar than this figure would indicate. There are also eight species common to the Vermejo flora of Colorado and New Mexico, all but one dicotyledons, and including several that have been found nowhere else, as the abundant *Cissites panduratus* Knowlton. This would serve to confirm Knowlton's contention that the Vermejo is older than Laramie, since the only Ripley species recorded from the Laramie is *Myrica Torreyi*, which also occurs in post-Laramie deposits in the West. Five Ripley species are found in beds in the West that are referred to the Montana Group, four in the Mesa Verde formation, two in the Fox Hills and five in the Fruitland formation.

As regards comparisons with European Upper Cretaceous floras five species are recorded from beds on that continent classed as Cenomanian, two from beds classed as Turonian, three from beds classed as Emscherian and six from beds which are either Santonian or Campanian in age. The Ripley flora contains noticeable elements common to that of the sands of Aix-la-Chapelle (Aachen). How many it is not possible to determine since large collections from around Aix-la-Chapelle made by Debey were never studied and only the ferns have received adequate treatment. The plants described from the plastic clays of Baume (St. Vaast) by Coemans and found at La Louvière are probably of the same age.

There has been considerable discussion and differences of opinion regarding the age of sands of Aix-la-Chapelle. These sands contain a sparse shallow water marine fauna with *Exogyra*, *Trigonia*, *Eriphyla*, *Inoceramus*, etc., and lenses of clay containing fossil plants. The sands are overlain by a highly fossiliferous glauconitic sand—the *Actinocamax quadratus* zone of the Campanian. This relationship would seem to indicate that the underlying plant bearing beds represented the littoral and continental deposits of the Santonian or at most could not be older than the lower Emscherian Coniacian substage. Despite this Haug refers these sands to the Turonian.

They are siliceous and cross-bedded and in part represent coastal dune sands so that they might conceivably be considerably older than the overlying strictly marine sediments. The question

is important because I regard the Ripley as about the same age, but it cannot perhaps be settled in the present state of our knowledge. I am disposed, however, to regard them as representing the Santonian substage or upper Emscherian.

The present Ripley flora shows no forms that are common to the abundant Wilcox or lower Eocene flora of the Mississippi embayment region—the only forms doubtfully recorded from Eocene in other regions being *Geonomites Schimperi* and the wholly worthless *Halymenites major*. Despite this lack of identical species, which might be expected, the Ripley flora does contain a number of types which become differentiated subsequently and are characteristic elements of the lower Eocene flora in southeastern North America. These are all angiosperms—the pteridophytes and coniferophytes all having become extinct both as to genera and species, or restricted to other regions in the case of some of the coniferophyte genera, before the dawn of the Eocene. Eocene praenuncial characters are seen in the Ripley *Geonomites*, *Drophyllum*, *Celtis*, *Artocarpus*, *Capparis*, *Dalbergia*, *Gleditsiophyllum*, *Cedrela*, *Dillenites*, *Ternstroemites*, *Lauraceae*, *Myrcia*, *Chrysophyllum*, *Bumelia*, and *Apocynophyllum*. Many of these are, of course, coastal types that might be expected to persist in a but slightly changed environment but the same is true as regards habitat of the majority of earlier Upper Cretaceous floras of the Atlantic Coastal Plain so that these differences in the Ripley flora as compared with antecedent floras may truly be regarded as of chronologic value.

Detailed comparisons with the extensive Wilcox flora shows many striking differences. In the latter the old Mesozoic coniferophyte elements are all gone and there are in the Ripley numerous genera of angiosperms commonly considered as temperate forest types such as *Salix*, *Fagus*, *Celtis*, *Liriodendron*, *Platanus*, *Acer*, *Cornophyllum* and *Andromeda*, which are apparently lacking along the Eocene coast of the Mississippi Gulf, although present in the Rocky Mountain and Great Plains region at that time. This would seem to indicate some climatic distinction between Ripley and Wilcox conditions and I am disposed to so consider it, in which event the Ripley would be more distinctly temperate than the Wilcox.

That students in general have underestimated the contrast between Upper Cretaceous and Eocene floras is, I think, obvious. It is the fashion to picture the incoming of the angiosperms in Upper Cretaceous times as a sudden and overwhelming event which in Cenomanian times transformed the Mesozoic floras of ferns, cycadophytes and conifers into an essentially Cenozoic flora of broad-leafed modern forests. At the beginning of Lower Cretaceous time the floras, as might be predicated *a priori*, were essentially Jurassic in type. Only gradually do they become typically Cretaceous and those elements that give them a Cretaceous facies linger in gradually diminishing numbers to the close of the Upper Cretaceous. Floras as early as the Albian show a variety of dicotyledons and many still existing genera are recognized but the numerical representation of dicotyledons in the rocks tends to be illusory, and a large number of the Cretaceous dicotyledons are more or less synthetic types, if one is justified in drawing such conclusions from the evidence of foliage alone. The lower Eocene introduces us to floras of a decidedly different facies and ones that distinctly show a great Cenozoic modernization, despite the difficulty of reflecting this in the current nomenclature of paleobotany. Moreover when it comes to details the change is profound. If the Ripley flora be compared with the Wilcox flora of the same general region the two are seen to be almost totally unlike though living under apparently similar environmental conditions. Both are lowland coastal floras, both are warm temperate in type and yet they have no common species. A tyro would immediately recognize the one as Cretaceous and the other as Tertiary. The Cretaceous cycadophytes and conifers have disappeared in the interval between the two. The flowering plants are distinctly better differentiated and more modern. That these Eocene floras as well as the Upper Cretaceous dicotyledons had ancestors is no more pertinent than the fact that the Eocene mammals had ancestors, in fact the comparison is not inept since the evolution of the flowering plants was, I believe, the major factor that made possible the evolution of the mammals.

It may be noted that of the genera identified in the Ripley flora thirty-five, or 51 per cent, are extinct. Most of these are form-genera of angiosperms and therefore not as precise as

might be wished, although some of these obviously, as in the case of *Ternstroemites*, represent the stock from which the Tertiary and existing genera were differentiated, and it is noteworthy that sixteen of the genera have not been recognized in post Cretaceous deposits. The following are the extinct genera of the Ripley flora: *Halymenites, Raphaelia, Dryopterites, Monheimia, Taeniopteris, Protophyllocladus, Widdringtonites, Cunninghamites, Moriconia, Geinitzia, Alismaphyllum, Doryanthites, Dioscorites, Geonomites, Dryophyllum, Menispermites, Acaciophyllites, Mimosites, Caesalpinites, Gleditsiophyllum, Leguminosites, Euphorbiophyllum, Manihotites, Cissites, Grewiopsis, Dillenites, Ternstroemites, Laurophyllum, Myrtophyllum, Cornophyllum, Acerates, Apocynophyllum, Calcites, Carpolithus, Phyllites.*

There follows a systematic list of the plants that have been identified from the Ripley formation. These will be fully described and illustrated in a Professional Paper of the U. S. Geological Survey, the manuscript of which has already been submitted, but which will probably be several years getting into print.

THALLOPHYTA ?

Halymenites major Lesq.

LEPIDOPHYTA ?

LYCOPODIALES ?

Selaginellaceae ?

Selaginella laciniata Lesq.

PTERIDOPHYTA

FILICALES

Asplenium calopteris (D. & E.) Heer
Raphaelia neuropteroides D. & E.
***Raphaelia* sp. nov.**
Monheimia aquisgranensis D. & E.
Dryopteris Stephensoni Berry
***Taeniopteris* sp.**

CONIFEROPHYTA

CONIFERALES

Protophyllocladus lobatus Berry
Widdringtonites Reichii (Ett.) Heer
Moriconia cyclotoxon D. & E.
Moriconia americana Berry
Geinitzia formosa Heer
Araucaria bladenensis Berry
Araucaria Jeffreyi Berry
Cunninghamites elegans (Corda) Endl.
Dammara acicularis Kn.

ANGIOSPERMOPHYTA

NAIADALES

Naiadaceae

***Potamogeton* sp. nov.**
***Alismaphyllum* sp. nov.**

LILIALES

Dioscoreaceae

***Dioscorites* sp. nov.**

ARECALES

Arecaceae

Geonomites Schimperi Lesq. — *Sabalites* sp.

Dicotyledodae

CHORIPETALAE

JUGLANDALES

Juglandaceae

Juglans similis Knowlton — *Juglans* sp. nov.

Myricaceae

Myrica ripleyensis Berry — *Myrica Brittoniana* Berry
Myrica Johnstrupi (Heer) Berry — *Myrica* 7 *spp. nov.*
Myrica Torreyi Lesq.

SALICALES

Salicaceae

Salix Gardneri Knowlton

FAGALES

Fagaceae

Dryophyllum gracile Debey — *Fagus* sp. nov.
Dryophyllum sp. nov.

URTICALES

Ulmaceae

Celtis sp. nov.

Moraceae

Artocarpus sp. nov. — *Ficus Leei* Knowlton
Ficus Krausiana Heer — *Ficus georgiana* Berry
Ficus crassipes (Heer) Heer — *Ficus* 4 spp. nov.
Ficus celtifolius Berry

PLATANALES

Platanaceae

Platanus ripleyensis Berry — *Platanus* sp. (*cf. Credneria*)

RANALES

Magnoliaceae

Liriodendron laramiense Ward — *Magnolia Capellini* Heer

Menispermaceae

Menispermites variabilis Berry

PAPAVERALES

Capparidaceae

Capparis sp. nov.

ROSALES

Mimosaceae

Acaciophyllites sp. nov. — *Mimosites* sp. nov.

Caesalpinaceae

Caesalpinites 2 spp. nov. — *Bauhinia ripleyensis* Berry

Papilionaceae

Dalbergia 3 spp. nov.

Leguminosae (position uncertain)

Gleditsiophyllum 3 spp. nov.
Leguminosites 2 spp. nov.
Leguminosites canavalioides Berry

GERANIALES

Meliaceae

Cedrela sp. nov.

Euphorbiaceae

Euphorbiophyllum antiquum Sap. & Mar.
Euphorbiophyllum 3 spp. nov.

SAPINDALES

Celastraceae

Celastrophyllum carolinensis Berry
Pachystima (?) *cretacea* Berry
Celastrophyllum 5 spp. nov.

Aceraceae

Acer sp. nov.

RHAMNALES

Rhamnaceae

Rhamnus sp. nov.
Zizyphus laurifolius Berry
Rhamnus ripleyensis Berry
Zizyphus 2 spp. nov.

Vitaceae

Cissites crispus Velenovsky
Cissites panduratus Knowlton

MALVALES

Tiliaceae

Grewiopsis 2 spp. nov.

Sterculiaceae

Sterculia Snowii tennesseensis Berry

PARIETALES

Dilleniaceae

Dillenites sp. nov.

Ternstroemiaceae

Ternstroemites 3 spp. nov.

THYMELEALES

Lauraceae

Cinnamomum Newberryi Berry
Laurus atanensis Berry
Cinnamomum 4 spp. nov.
Laurus coloradensis Knowlton
Nectandra sp. nov.
Laurus 2 spp. nov.
Malapoenna horellensis Berry
Laurophyllum sp. nov.

MYRTALES

Myrtaceae

Myrcia havanensis Berry
Eugenia ? *anceps* Berry
Myrcia sp. nov.
Myrtophyllum angustum (Velen.) Berry

UMBELLALES

Araliaceae

Aralia wellingtoniana n. var.
Aralia sp. nov.

Cornaceae ?

Cornophyllum sp. nov.

GAMOPETALAE

ERICALES ?

Ericaceae ?

Andromeda sp. nov.

EBENALES

Sapotaceae

Chrysophyllum sp. nov. *Bumelia* 2 spp. nov.

GENTIANALES

Asclepiadaceae

Acerates sp. nov.

Apocynaceae

Apocynophyllum 5 spp. nov.

POSITION UNCERTAIN

Calycites sp. nov. *Carpolithus* 3 spp. nov.

Phyllites 3 spp. nov. *Doryanthites cretacea* Berry

THE JOHNS HOPKINS UNIVERSITY,
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INDEX TO AMERICAN BOTANICAL LITERATURE

1910–1920

The aim of this Index is to include all current botanical literature written by Americans, published in America, or based upon American material; the word America being used in the broadest sense.

Reviews, and papers that relate exclusively to forestry, agriculture, horticulture, manufactured products of vegetable origin, or laboratory methods, are not included, and no attempt is made to index the literature of bacteriology. An occasional exception is made in favor of some paper appearing in an American periodical which is devoted wholly to botany. Reprints are not mentioned unless they differ from the original in some important particular. If users of the Index will call the attention of the editor to errors or omissions, their kindness will be appreciated.

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Atanasoff, D. *Fusarium*-blight (scab) of wheat and other cereals. Jour. Agr. Research **20**: 1–32. *pl. 1–4.* + *f. 1–2.* 1 O 1920.

Barker, E. E. La arboleda de las carreteras. Revista Agric. Puerto Rico **5**: 41–46. O 1920.

Benoist, R. Contribution à l'étude de la flore de la Guyane française. Bull. Mus. Nat. Hist. Natur. **1920**: 351–357. 1920.

Includes 2 new species of *Casearia*.

Berry, E. W. The ancestors of the sequoias. Sci. Am. Monthly **2**: 207, 208. N 1920.

Bisby, G. R., & Tolaas, A. G. Potato diseases in Minnesota. Univ. Minnesota Agr. Exp. Sta. Bull. **190**: 1–44. *f. 1–28.* Je 1920.

Bitting, K. G. The effect of certain agents on the development of some moulds (*Penicillium expansum*, *Alternaria Solani*, and *Oidium lactis*). pp. 1–176. *pl. 1–62.* Washington. N 1920.

Blaringhem, L. Sur les collections de plantes vivantes de l'Arnold Arboretum (Université d'Harvard, près Boston, États-Unis). Bull. Soc. Bot. France **66**: 403–405. 7 My 1920.

Boyce, J. S. The dry-rot of incense cedar. U. S. Dept. Agr. Bull. 871: 1–58. *pl. 1–3* + *f. 1–3.* 10 N 1920.

Boynton, K. R. *Ceratostigma plumbaginoides.* Addisonia **5**: 45, 46. *pl. 183.* 30 S 1920.

Boynton, K. R. *Monarda media.* Addisonia **5**: 39. *pl. 180.* 30 S 1920.

Carey, C. L. A method of preparation and some properties of a starch gel. Bull. Torrey Club **47**: 455–463. 29 O 1920.

Chase, V. H. Francis Eugene M'Donald. Rhodora **22**: 145, 146. *portrait.* 29 O 1920.

Chidsey, C. E. Knots and boles on forest trees. Sc. Am. Monthly **2**: 209, 210. N 1920.

Clinton, G. P. New or unusual plant injuries and diseases, found in Connecticut, 1916–1919. Connecticut Agr. Exp. Sta. Bull. *222*: 397–482. *pl. 33–55.* Au 1920.

Clute, W. N. How often does a branch bear leaves? Gard. Chron. **24**: 375. N 1920.

Clute, W. N. Naming flowers. Flower Grower **7**: 171. N 1920.

Coburn, L. H. *Marsilea quadrifolia* in Maine. Rhodora **22**: 156. 29 O 1920.

Couch, J. F., & Giltner, L. T. An experimental study of *Echinacea* therapy. Jour. Agr. Research **20**: 63–84. 1 O 1920.

Creswell, M. The American ash. Nature Study Rev. **16**: 279–284. O 1920.

Doolittle, S. P. The mosaic disease of cucurbits. U. S. Dept. Agr. Bull. 879: 1–69. *pl. 1–10.* 15 N 1920.

Earle, F. S. La extirpación del mosaico de la caña como medio de represión. Puerto Rico Dept. Agric. y Trab. Bol. **22**: 1–19. Ja 1920.

Earle, F. S. Sugar cane root disease. Jour. Dept. Agr. Porto Rico **4**: 27. Ja 1920.

Espino, R. B. Some aspects of the salt requirements of young rice plants. Philipp. Jour. Sci. **16**: 455–523. *pl. 1.* My 1920.

Fernald, M. L. *Gaultheria procumbens*, L., forma *suborbiculata*, n. f. Rhodora **22**: 155, 156. 29 O 1920.

Fernald, M. L. *Lactuca hirsuta*, Muhl., forma *calvifolia*, n. f. Rhodora **22**: 156. 29 O 1920.

Gersdorff, C. E. F. The history of the rose in America. Flower Grower **7**: 169, 170. N 1920.

Gile, P. L., & Carrero, J. O. Cause of lime-induced chlorosis and availability of iron in the soil. Jour. Agr. Research **20**: 33–61. *pl. 5–6.* 1 O 1920.

Greaves, J. E. & Carter, E. G. Influence of moisture on the bacterial activities of the soil. Soil Sci. **10**: 361–387. *f. 1–4.* N 1920.

Hauman, L. Un viaje botanico al lago Argentino [Patagonia]. An. Soc. Cient. Argent. **89**: 179–281. *pl. 1–11 + f. 1–12.* 1920.

Hess, H. M. The birches. Nature Study Rev. **16**: 307–316. O 1920.

Hitchcock, A. S. The North American species of *Chaetochloa.* Contrib. U. S. Nat. Herb. **22**: 155–208. *f. 36–62.* 1920.
4 new combinations.

Hitchcock, A. S. The North American species of *Echinochloa.* Contrib. U. S. Nat. Herb. **22**: 133–153. *f. 25–35.* 1920.
3 new combinations.

Hitchcock, A. S. The North American species of *Isachne.* Contrib. U. S. Nat. Herb. **22**: 115–121. *pl. 25–32.* 1920.

Hitchcock, A. S. The North American species of *Oplismenus.* Contrib. U. S. Nat. Herb. **22**: 123–132. *f. 21–24.* 1920.

Hutchinson, J. *Bocconia* and *Macleaya.* Kew Bull. Misc. Inform. **1920**: 275. 1920.
Includes 4 new American species of *Bocconia.*

Johansen, H. El cultivo del toronjo. Revista Agric. **16**: 199–202. 31 O 1920. [Illust.]

Johnston, E. S. Nutrient requirement of the potato plant grown in sand. Cultures treated with "Type I" solutions. Soil. Sci. **10**: 389–408. *pl. 1 + f. 1–5.* 1920.

Kunkel, L. O., & Orton, C. R. The behavior of American potato varieties in the presence of the wart. U. S. Dept. Agr. Circ. 111: 10–17. *f. 2–3.* O 1920.

Kunkel, L. O., & Orton, C. R. A new host for the potato wart disease. U. S. Dept. Agr. Circ. 111: 17–18. *f. 4.* O 1920.

Lankester, C. H. Orchids in Costa Rica. Orchid Rev. **28**: 129–132. O 1920.

Lewis, I. F., & Zirkle, C. Cytology and systematic position of *Porphyridium cruentum* Naegeli. Am. Jour. Bot. **7**: 333–339. *pl. 20, 21.* 5 N 1920.

Lyman, G. R. Potato wart in the United States. U. S. Dept. Agr. Circ. **111**: 3–10. *f. 1.* O 1920.

Matz, J. A new vascular organism in sugar cane. Jour. Dept. Agr., Porto Rico. **4**: 41–46. *f. 7–9.* Ja 1920.
Plasmodiophora vascularum, sp. nov.

Matz, J. Investigations of root disease of sugar cane. Jour. Dept. Agr. Porto Rico. **4**: 28–40. *f. 1–6.* Ja 1920.

Matz, J. El mal del guineo. Puerto Rico Dept. Agric. y Trab. Circ. 25: 1–7. My 1920.

Merrill, E. D. On the identity of *Aegiphila viburnifolia* Jussieu. Philipp. Jour. Sci. **16**: 449–451. My 1920.

Murrill, W. A. Botanizing at Blacksburg, Virginia. Jour. New York Bot Gard. **53**: 191–193. O 1920.

Nash, G. V. *Clethra barbinervis.* Addisonia **5**: 41. *pl. 181.* 30 S 1920.

Nash, G. V. *Crataegus Phaenopyrum.* Addisonia **5**: 33. *pl. 177.* 30 S 1920.

Nash, G. V. *Solidago rugosa.* Addisonia **5**: 43, 44. *pl. 182.* 30 S 1920.

Nash, G. V. *Stephanandra Tanakae.* Addisonia. **5**: *pl. 179.* 30 S 1920.

Nash, G. V. *Viburnum Sieboldii.* Addisonia **5**: 35–36. *pl. 178.* 30 S 1920.

Nichols, G. E. The vegetation of Connecticut—VIII. Bull. Torrey Club **47**: 511–548. *f. 1–10.* 24 N 1920.

Phipps, W. H. Effect of pollenation on the life of flowers. Flower Grower **7**: 182. N 1920.

Record, S. J. Scented woods. Am. For. **26**: 665–672. N 1920.

Reed, H. S. Slow and rapid growth. Am. Jour. Bot. **7**: 327–332. *f. 1–2.* 5 N 1920.

St. John, H. A teratological specimen of *Aralia hispida.* Rhodora **22**: 152–153. 29 O 1920.

Saunders, E. R. Heredity. Sci. Monthly **11**: 435–440. N 1920.

Sharp, L. W. Somatic chromosomes in *Tradescantia.* Am. Jour. Bot. **7**: 341–354. *pl. 22, 23.* 5 N 1920.

Small, J. K. *Grossularia curvata.* Addisonia **5**: 47, 48. *pl. 184.* 30 S 1920.

Smith, A. A lesson on plant physiology and the plant in relation to its environment. Gard. Chron. Am. **24**: 376–379. N 1920.

Sprague, T. A. *Stellaria* or *Alsine.* Kew Bull. Misc. Inform. **1920**: 308–318. 1920.

Stakman, L. J. A *Helminthosporium* disease of wheat and rye. Univ. Minnesota Agr. Exp. Sta. Bull. 191: 1–18. *pl. 1–5.* Jl 1920.

Stevens, F. L., Pammel, L. H., & Cook, M. T. Byron David Halsted. Am. Jour. Bot. **7**: 305–317. *pl. 19.* 5 N 1920.

Sturtevant, R. S. Irises from Japan. Brooklyn Bot. Gard. Record **9**: 115–119. 1920.

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BULLETIN

OF THE

TORREY BOTANICAL CLUB

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Neomillspaughia, a new genus of Polygonaceae, with remarks on related genera

S. F. Blake

(WITH PLATE 1)

The genus *Campderia* Benth.* of the Polygonaceae was established in 1844, with the single species *C. floribunda*† from Tiger or Tigre Island, Gulf of Fonseca, Honduras, and was distinguished from *Coccoloba* by the fact that the perigone in fruit was not adherent to the achene. In the Genera Plantarum‡ it was maintained as a genus with two or three species, separated from *Coccoloba* by its accrescent calyx lobes and scarcely accrescent tube, all essentially free from the trigonous achene. In *Coccoloba* the perianth tube alone was said to be accrescent and often adnate to the globose or ovoid achene, In 1890, in his monograph of *Coccoloba*, Lindau§ referred *Campderia* to *Coccoloba* as a section containing thirteen species, distinguished from *Eucoccoloba* by its not elongating pedicels and by the fact that the limb and not the tube of the calyx is accrescent. There can be little question of the propriety of this arrangement. In habit and in all major characters except those mentioned *Campderia*, as exemplified by its type species and by those included in it by Lindau, agrees

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* Bot. Sulph. 159. *pl.* 52. 1844.

† Bot. Sulph. 160. 1844.

‡ Benth. & Hook. Gen. Pl. 3: 102. 1880.

§ Bot. Jahrb. 13: 111, 121. 1890.

precisely with *Coccoloba*, and the differences indicated are so comparatively slight and so weakened by intergradient forms that they can not be considered of generic value.

Of the five species of *Campderia* described up to 1890, representing three valid species, all are accounted for by Lindau in his monograph of *Coccoloba*. A plant of very different characters, representing an undescribed genus, has more recently been described from Honduras by Donnell Smith* under the name *Campderia paniculata*, and with it is clearly to be associated another species from Yucatan described by Gross† in 1913 as *Podopterus emarginatus*. Both of these are shrubs or trees with orbicular leaves, cordate at base and strongly emarginate at apex. The inflorescence is a terminal panicle compounded of numerous slender racemes, the branches minutely scaly-bracted at base. Such an inflorescence is found in only two species of *Coccoloba*, forming the section *Paniculatae* of Meisner. It is in the perianth, however, that the chief distinguishing characters of this new genus appear. The tube is very short, and the five segments are in two distinct series; the three outer are distinctly winged from apex to base, and the wings are slightly decurrent on the pedicels. The two inner are flat, wingless, and shorter than the outer. In fruit all are somewhat accrescent, dry, and entirely free from the achene. In *Coccoloba*, on the other hand, the five perianth-segments are similar or subsimilar, more or less fleshy or coriaceous, in fruit flat or rarely slightly carinate but never winged, and usually adherent to the achene. The affinity of the new genus is clearly with *Podopterus* rather than with *Coccoloba*. From the latter it may be distinguished by its paniculate inflorescence, more narrowly winged perianth, and slightly winged scarcely elongated fruiting pedicels. In *Podopterus* the flowers are borne in dense fascicles at the tips of very short branchlets or in short axillary racemes, and the perianth and the fruiting pedicels are very strongly winged. The exact nature of the inflorescence in the type species of *Podopterus*, *P. mexicanus*, not clearly described by previous authors, deserves a word of explanation. The leaves are alternate and usually bear fascicles of two to four similar ones

* Bot. Gaz. 27: 440. 1899.

† Rep. Nov. Sp. Fedde 13: 218. 1913.

in their axils. After the fall of these leaves, the extremely abbreviated branchlet on which they were borne bears at its tip a dense fascicle of flowers. It is from the appearance of the old branches denuded of leaves and bearing numerous fascicles of flowers that Bentham's description of the inflorescence has been drawn. The inflorescence of the new species *P. guatemalensis* described below is precisely the same. In *P. cordifolius* Rose & Standley, however, the flowers are borne in short axillary racemes, 2–3 cm. long, often with a cluster of small leaves at the base, and as they are arranged in several successive axils and do not appear until after the fall of the primary leaves subtending them they simulate a panicle in appearance.

There is considerable diversity in the descriptions of the flower of *Podopterus* by different authors. Humboldt and Bonpland* in their original description ascribe to it six sepals, three outer and three inner, the outer being winged, the inner flattish and scarcely shorter than the outer. The stamens are described and figured as six, with subulate glabrous filaments, and the single ovule is said to be erect. Meisner's description† agrees essentially with theirs, with the added point that the ovule is subsessile. Bentham and Hooker's description‡ is taken largely from that of Humboldt and Bonpland, owing to their lack of complete material. The filaments are said to be filiform and the ovule subsessile. Baillon§ gives the number of sepals as five or six, the stamens as six to nine, with subulate filaments, and the ovule as stipitate. His figures show five sepals and eight stamens. Dammer,‖ in the Pflanzenfamilien, gives the sepals as five, three outer and two inner, the stamens as eight, and the ovule as stipitate. In all the specimens I have examined (representing all the known species), with one exception, the sepals are five and the stamens eight, with subulate glabrous filaments; in a single flower of *P. cordifolius*, however, out of three examined, there were nine stamens. The seed has not yet been described, but fully mature fruits of *Podopterus mexicanus* collected by Pringle (No. 10181) at Tomellin Canyon,

* Pl. Aequin. **2**: 89. *pl. 107*. 1812.

† DC. Prodr. **14**: 171. 1856.

‡ Gen. Pl. **3**: 104. 1880.

§ Hist. Pl. **11**: 394. 1892.

‖ Engler & Prantl, Pflanzenfamilien 3^{1a}: 32. 1892.

Oaxaca, May 14, 1906, and of *P. guatemalensis*, collected by Popenoe, enable me to give its characters.

The seed of *Podopterus mexicanus* is trigonous, either equal-sided or conforming to the shape of the achene (trigonous, with one side flat and two narrower and sulcate), and acute at apex. The plentiful albumen is farinaceous, slightly ruminate, and gives the starch reaction with iodine. The embryo is subcentral and straight, either flat or bent longitudinally in a boat-shaped fashion, when one half lies parallel to the flat side of the seed and the other enters the central lobe. The cotyledons are flat, or bent as described, and the radicle superior, slender, more than half as long as the thin oval cotyledons, ascending from their slightly cordate base. In young ovaries the ovule is erect and stipitate, as described by Baillon, not subsessile as described by Bentham and Hooker. In *P. cordifolius* the ovule is pendulous on a basal funicle longer than itself in the young flower. Older flowers of this species have not been examined.

In mature achenes of *Podopterus guatemalensis* the seed is trigonous, rounded on each side or with two sides slightly sulcate. The embryo is subcentral, in cross-section somewhat boat-shaped or bent in an irregular S-form. The oval cotyledons are unequal at base, oblique on one side and on the other cordate and accumbent to the base of the ascending radicle.

In 1901* Rolfe described and figured a new genus *Gymopodium* from British Honduras, said to be related to *Podopterus* but to be distinguished by its wingless pedicels and its nine stamens. Comparison with the description and specimens of the genus *Millspaughia* described several years later by Robinson† from Yucatan shows that the two genera are identical. The genus is not closely allied to *Podopterus*, however, as Rolfe considered it, probably on the basis of the tribal grouping in the Genera Plantarum, but is a near relative of *Antigonon* Endl., with which it was associated by Robinson.

Antigonon is placed by Bentham and Hooker in the tribe Coccolobeae, which is separated from the tribe Triplarideae, in which *Podopterus* is placed, chiefly by its five-parted perianth

* Hook. Icon. **27**: *pl. 2699*. 1901.

† Bot. Jahrb. **36** (Beibl. **80**): 13. 1905.

and usually eight stamens, while in the latter tribe the perianth is six-parted and the stamens, three, six, nine or many. As shown above, however, *Podopterus* is nearly always pentamerous in respect to its perianth and octandrous, the only specimens on record with hexamerous flowers being those from which the original description was drawn. Dammer describes the perianth of *Antigonon* as penta- or hexamerous, and figures it as hexamerous, but the normal number of perianth parts is certainly five, as given by Bentham and Hooker, and I have seen no specimens with six sepals. In his key to the tribe Coccolobeae, rightly including *Podopterus*, Dammer keys out *Antigonon* as having "Blh. [Blütenhülle] ohne Flügel," as opposed to the genera *Brunnichia* and *Podopterus* which have "Blh. mit Flügeln," but in his description of the genus he says "die 3 äusseren Blütenhüllb. bei der Fruchtreife . . . Flügel bildend." The distinction obviously intended is that in *Antigonon* the outer perianth segments lack dorsal wings and the tube is wingless, while one or both of these features are present in the two allied genera. The distinguishing characters between the genera considered above, with their close ally *Brunnichia*—including all the genera of the tribe Coccolobeae as defined by Dammer, with the exception of *Coccoloba* and *Muehlenbeckia*—may be expressed in the following key:

Perianth tube in fruit strongly accrescent, corky or coriaceous, longer than the limb, including the achene, one- or two-winged, the wings decurrent on the pedicel; perianth segments not winged; frutescent, climbing by tendrils; perianth segments five; stamens "five" to "nine," usually eight; ovule at first pendulous on a basal funicle about its own length, then erect; albumen six-sulcate by the intruded testa, otherwise not ruminate; embryo marginal, in one of the lobes, straightish. 1. *Brunnichia*.

Perianth tube scarcely accrescent in fruit, not corky or coriaceous, much shorter than the limb, not including the achene, wingless or three-winged.

Perianth segments without dorsal wings.

Perianth segments five, rarely "six;" filaments normally eight, united at base or to middle into a ring; ovule at first pendulous on a basal funicle slightly longer than itself, later erect; achene broadly ovoid, subterete below, sharply three-angled above, glabrous; embryo subcentral, flattish, the cotyledons not cordate at base; albumen strongly ruminate; plants woody only at base, climbing by tendrils. 2. *Antigonon*.

Perianth segments six; filaments normally nine (six outer, three inner), free; ovule erect from the first, on a stipe several times its length; achene ovoid-lanceolate, three-angled throughout, with sulcate sides, pubescent; embryo subcentral, somewhat boat-shaped, its cotyledons cordate and unequal at base, the radicle erect; albumen not ruminate; shrubs or trees, without tendrils, not scandent. 3. *Gymnopodium.*

Outer perianth segments with dorsal wings, the wings more or less decurrent on the pedicels.

Flowers in panicled racemes; perianth segments narrowly winged, the wings scarcely decurrent on the pedicels; filaments pubescent; albumen not ruminate. 4. *Neomillspaughia.*

Flowers in axillary fascicles or short axillary racemes; perianth segments broadly winged, the wings broadly decurrent on the pedicels; filaments glabrous; albumen ruminate. 5. *Podopterus.*

1. BRUNNICHIA Banks

With the exception of *Muehlenbeckia*, which is found in tropical America and in Australia, New Zealand, and the islands of the Pacific, *Brunnichia* is the only genus of the tribe Coccolobeae not confined to America. The type species, *B. cirrhosa* Gaertn., occurs in eastern North America, the three other known species coming from the region of the Belgian Congo and Camerun in western Africa. The genus may be divided into two sections, separated by habitat and by definite fruiting characters. In the section **Eubrunnichia**, sect. nov., including only the type species, *B. cirrhosa*, the tube of the perianth and the pedicel bear a single broad wing, and the perianth tube is much thickened and corky in fruit. In the African group, which may be called section **Dipteropodium**, sect. nov., the tube of the perianth and the pedicel bear two broad wings, and the perianth tube in fruit is coriaceous and not obviously thickened. This section includes three species, *B. africana* Welw. (type), *B. erecta* Aschers., and *B. congoensis* Dammer.* Of this group I have examined only a sheet of *B. africana* var. *glabra* Dammer, in the U. S. National Herbarium.

Brunnichia erecta Aschers. was originally described as an erect

* For an account of the African species, see Dammer, Bot. Jahrb. **26**: 347–357. 1899.

shrub without tendrils; but Dammer has found what he considers a young and undeveloped tendril in a specimen of this species, and states that all the specimens known are merely pieces from the region of the inflorescence, so that it is probable that this species agrees with the other better known members of the genus in the possession of tendrils.

The descriptions of the embryo given by Bentham and Hooker ("embryo in uno lobo leviter incumbenti-incurvus") and by Dammer, in the Pflanzenfamilien ("E. incumbent, einwärts gekrümmt Oll"), do not entirely agree with what I have found in the dissection of numerous seeds of *B. cirrhosa*. The albumen is six-sulcate by the intruded testa, otherwise not ruminate; the embryo is marginal in one of the lobes, straightish or very slightly incurved, and the radicle erect and in no way applied to the cotyledons. In all the specimens of the African species so far described the achenes, although in some apparently mature, have been empty of seed and filled with a fungal growth.

2. ANTIGONON Endl.

The perianth segments are given as five by Bentham and Hooker and by Baillon. Dammer, in the Pflanzenfamilien, gives them as five or six, and figures a flower of *A. leptopus* with six segments. I have seen no flower with six perianth parts, and believe this number must be very rare if not abnormal. The embryo, in the seeds examined, was subcentral, flat, and straight.

3. GYMNOPODIUM Rolfe, Hook, Icon. **27**: *pl. 2699*. 1901

Millspaughia Robinson, Bot. Jahrb. **36** (Beibl. **80**): 13. 1905.

The filaments in this genus are normally nine, as described by Rolfe, the six outer inserted at the outer edge of a short thickened somehat knobby disk at the base of the ovary, the three inner borne on this disk opposite the sulcate faces of the ovary. They are free, in which the genus differs from *Antigonon*, where an annulus of basally united filaments is always developed. The other characters by which *Gymnopodium* differs from *Antigonon* have already been indicated above. The ovule in *G. antigonoides* is erect on a funicle several times its length, not subsessile as described by Rolfe in *G. floribundum*. The three species now known may be distinguished by the following key:

Leaves glabrous. 1. *G. floribundum.*
Leaves pubescent at least when young.
  Leaves obovate or oval, obtuse or rounded; outer perianth segments cordate at base. 2. *G. antigonoides.*
  Leaves ovate or broadly ovate, acutish; outer perianth segments not cordate at base. 3. *G. ovatifolium.*

1. GYMNOPODIUM FLORIBUNDUM Rolfe, Hook. Icon. **27**: *pl. 2699.* 1901

Millspaughia leiophylla Blake, Contr. Gray Herb. n. ser. **52**: 62. 1917.

Originally described from specimens collected on pine ridges at Manatee, British Honduras, by E. J. F. Campbell (No. 60). The specimens from which *M. leiophylla* was described were collected in swampy saline ground at Manatee Lagoon, British Honduras, by M. E. Peck (No. 320).

2. **Gymnopodium antigonoides** (Robinson) Blake, comb. nov.

Millspaughia antigonoides Robinson, Bot. Jahrb. **36** (Beibl. **80**): 14. 1905.

This species has hitherto been known only from Yucatan, but is also represented by specimens in the National Herbarium collected at Tuxtla Gutierrez, Chiapas, on March 8, 1904, by E. A. Goldman (No. 743).

3. **Gymnopodium ovatifolium** (Robinson) Blake, comb. nov.

Millspaughia ovatifolia Robinson, Bot. Jahrb. **36** (Beibl. **80**): 14. 1905.

Known only from Yucatan. Not examined by the writer in the present connection.

4. **NEOMILLSPAUGHIA** Blake, gen. nov.

Shrubs or trees; leaves alternate, orbicular, cordate at base, emarginate at apex, short-petioled, with deciduous ocreae; panicles terminal, compounded of racemes; peduncles of the racemes with small scarious bracts at base; ocreolae two- to six-flowered; pedicels filiform, narrowly three-winged toward apex, not lengthened in fruit, jointed much below the middle; perianth petaloid in flower, in fruit dry and accrescent, the tube very short, the three outer segments ovate or oval-ovate, winged throughout,

the wings decurrent on the upper part of the pedicel, more or less erose, the two inner segments oval-ovate or oval, plane, wingless, obtuse, slightly shorter than the outer; stamens eight or nine, the filaments inserted on the base of the perianth, united at base, subulate from a lance-ovate base, pubescent about to middle, the anthers suborbicular, dorsified in the middle, the cells free except at the point of attachment; ovary trigonous, glabrous, the ovule erect, subsessile; styles three, slender, with irregular capitate stigmas; achene trigonous-ovoid, acutish, with flat sides, the more or less persistent styles slightly exserted between the wings of the perianth; seed trigonous, one side flattish, the others sulcate; albumen not ruminate; embryo subcentral, straight, the superior radicle shorter than the suborbicular somewhat boat-shaped cotyledons.

Type species, *Campderia paniculata* Donn. Sm.

As *Millspaughia* Robinson has proved to be a synonym of *Gymnopodium*, the present genus may appropriately take the name *Neomillspaughia*, in honor of Dr. C. F. Millspaugh, botanical curator of the Field Columbian Museum, who has done so much to increase our knowledge of the flora of Yucatan.

Leaves 9–16 cm. wide, beneath rather densely sordid-puberulous; fruiting perianth 4.5 mm. long; achene 3 mm. long. 1. *N. paniculata.*

Leaves 4.5–9 cm. wide, beneath glabrescent except along the costa and the chief lateral veins; fruiting perianth 8 mm. long; achene 3.5 mm. long. 2. *N. emarginata.*

1. **Neomillspaughia paniculata** (Donn. Sm.) Blake, comb. nov.

Campderia paniculata Donn. Sm. Bot. Gaz. **27**: 440. 1899.

Known only from the type collection by C. Thieme (distr. Donn. Sm. No. 5604), from the Río Chamelecón, Department Santa Barbara, Honduras, altitude 500 meters, December, 1888.

2. **Neomillspaughia emarginata** (H. Gross) Blake, comb. nov.

Podopterus emarginatus H. Gross, Rep. Nov. Sp. Fedde **12**: 218. 1913.

This species was based on fruiting specimens collected in July in woods near Kabah, Yucatan, by Seler (No. 5600), and on flowering specimens collected near Izamal, Yucatan, July, 1895, by G. F. Gaumer (No. 750). Only the latter collection has been examined. This is said to be from a tree 15 meters (50 feet) high, common in forests and brush lands near Izamal.*

* Millsp. Field Col. Mus. Bot. 1: 294. 1896, under *Podopterus mexicanus.*

5. PODOPTERUS Humb. & Bonpl. Pl. Aequin. **2**: 89. *pl. 107.* 1812*

The characters of this genus have been indicated with sufficient detail in the discussion and key given above. The three species now known may be separated by the following key.

Flowers in fascicles; leaves obovate or oval-obovate.
  Leaves glabrous beneath or merely pilosulous at base of midrib, acute at base. 1. *P. mexicanus.*
  Leaves rather densely pilosulous on the surface as well as the veins beneath, rounded or cordate at base. 2. *P. guatemalensis.*
Flowers in short axillary racemes; leaves oval-ovate or ovate, cordate at base. 3. *P. cordifolius.*

1. PODOPTERUS MEXICANUS Humb. & Bonpl. Pl. Aequin. **2**: 89. *pl. 107.* 1812

The type of this species came from the State of Veracruz, between Veracruz and La Antigua. No material from Veracruz is in the National Herbarium, but the species is represented from Tamaulipas, Yucatan, Oaxaca, and also from Armeria, Colima, on the western coast, where it was collected by Palmer in 1891 (No. 1290).

Podopterus mexicanus was originally described and figured as having six perianth segments, six stamens, and leaves slightly hairy at base. In the later description of Kunth† the leaves and petioles were said to be glabrous. I have already discussed the question of the number of floral parts. It may noted that none of the specimens examined has leaves or petioles which can be called glabrous, there being always some pubescence at least on the margin of the petiole, which is sparsest in the two collections from Oaxaca now before me, and usually also at the base of the costa beneath. Dr. H. Lecomte, to whom I sent specimens for

* The date given for this name is taken from Sherborn & Woodward's paper on the dates of Humboldt and Bonpland's Voyage, Jour. Bot. **39**: 203. 1901. The page reference, which is the only one I have seen cited, has been verified for me by Dr. J. H. Barnhart. In the Library of Congress copy of this work *Podopterus* and *P. mexicanus* are published on p. 82, and another reference which I have had occasion to look up shows a similar discrepancy (p. 132 instead of the usually cited 139 for *Rhaptostylum*). It is evident that there were two editions of this work, both in folio, a fact which seems to have escaped the notice of bibliographers.

† H. B. K. Nov. Gen. et Sp. **2**: 181. 1817.

comparison, informs me that there are now no leaves on the specimens in the Paris Herbarium.

2. **Podopterus guatemalensis** Blake, sp. nov.

Shrub or tree; branches somewhat zigzag, with short internodes and spinescent branchlets, gray-barked and densely spreading-puberulous, becoming purplish-fuscous and glabrate; leaves in clusters of two to four; petioles densely sordid-pilosulous with loosely spreading hairs, 4–15 mm. long; blades broadly obovate or oval-obovate, 2.2–4.3 cm. long, 1.8–3.2 cm. wide, broadly rounded or obtuse, sometimes slightly emarginate, narrowed to a rounded or cordate base, coriaceous, above dull green or in age somewhat shining, along costa densely pilosulous, on surface essentially glabrous or sparsely spreading-pilosulous and glabrate, beneath dull green, along costa densely spreading-pilosulous, on surface densely, permanently, and sordidly spreading-pilosulous with loose hairs or sparsely so and subglabrate, finely prominulous-reticulate on both sides, the chief lateral veins about six pairs; fascicles many-flowered, on usually leafless branches; pedicels glabrous, 12–17 mm. long, winged for half their length or more, about 4.5 mm. broad at base of calyx; calyx in fruit 8 mm. long, glabrous, the three outer segments with a wing 2 mm. wide, the two inner ovate, obtuse, cucullate, 5 mm. long; stamens eight, the filaments glabrous, subulate; achene trigonous-ellipsoid, obtusish at each end, 5 mm. long, 2.5 mm. wide, flat or rounded on one side, sulcate on the others, pale brownish; styles three, spreading, 1 mm. long.

TYPE in the U. S. National Herbarium, No. 1038152, collected at Barranquillo, Department El Progreso, Guatemala, altitude 550 meters, March 15, 1920, by Wilson Popenoe (No. 973).

The following specimens have likewise been examined:—

GUATEMALA: El Rancho, Department Jalapa, March 10, 1905, *Kellerman 4994*.

The vernacular name of this species is given by Mr. Popenoe as "cruzito."

3. PODOPTERUS CORDIFOLIUS Rose & Standl. Proc. Biol. Soc. Washington **33**: 66. 1920

Originally described from a collection made by M. E. Jones (No. 103) at Manzanillo, Colima, on June 25, 1892. A specimen collected by C. R. Orcutt (No. 3306) at Tehuantepec, Oaxaca, on April 19, 1910, is also in the U. S. National Herbarium.

Explanation of plate 1

NEOMILLSPAUGHIA PANICULATA (Donn. Sm.) Blake

FIG. 1. Inflorescence and leaves, about 4/5 natural size.
FIG. 2. Portion of fruiting raceme, about natural size.
FIG. 3. Flower, about × 3½.
FIG. 4. Flower opened, about × 3½.
FIG. 5. Fruit, about × 3.
FIG. 6. Stamen, about × 5.
FIG. 7. Achene, about × 7.
FIG. 8. Achene in transverse section.

BV #3

"Unrecorded" genera of Rafinesque—I. Autikon Botanikon (1840)

Francis W. Pennell

Botanists have come to rely so fully on the thoroughness of the vast compliation of plant-names brought together in the Index Kewensis, that it is, to say the least, disconcerting to learn of names not recorded there. The libraries of England and the Continent fortunately, and naturally, contain the original descriptions of nearly all species ever published. Yet remarkable as was the diligence with which accessible volumes and journals were searched, it cannot be surprising to discover that some works, and particuliarly those produced elsewhere and but little welcomed in their time, were missed. Such were the works of Constantine Samuel Rafinesque, especially those written during the later lonely fruitful years of his life at Philadelphia.

Rafinesque had a varied scientific career, for some years in Sicily, but for most of his working life in the United States, as it was understood between 1802 and 1840, the year of his death. None of the early students of the American flora made more prolific contributions to our taxonomic knowledge, and no other was so vigorously original. The present-day student must appreciate the keenness of Rafinesque's judgments, no matter how much he may deplore the undisciplined enthusiasm with which were presented too slightly weighed conclusions, nor can we fail to do honor to the zeal which led this "improver" to the production at his own expense, or rather at his own continuous loss, of volume after volume giving a sustained presentment of his views on the nomenclature, taxonomy and evolution of plants, American and foreign.

Many of Rafinesque's botanical papers between 1815, the date of his permanent settlement in America, and 1836 are short and published in little-known magazines. His more pretentious works of this period, Florula Ludoviciana, 1817, and Medical Flora, 1828–30, are well indexed by the Kew bibliographers. But the papers in the American Monthly Magazine were not all seen by

them, and contain descriptions which are still practically unknown. During these years, as claimed by Rafinesque, a number of pamphlets were "published," but whether certain at Lexington, Kentucky, if actually issued, have survived in even a single copy is doubtful. It would have been more logical to have commenced a search for the unrecorded genera of Rafinesque with these earlier works, but the difficulty of the task has made me postpone such a paper.

In 1836 commenced the great period of Rafinesque's production. Then in a series of projects, each curtailed in execution, he tried to place before an unresponsive world his views. Many thought him "crazy," but who to-day can read such expressions as those presented in the letter to Dr. Torrey preserved in the Herbarium Rafinesquianum (p. 11–12) or the expositions in the introductions to the New Flora of America and the Flora Telluriana, and not consider that here was one of the truly striking forerunners of the Evolutionary Movement? His New Flora of North America and Flora Telluriana, his greatest works, are well indexed by the Kew compilers, so that later scientists have little excuse for the neglect with which these are treated. But the work which succeeded these, upon which he was writing at the time of his death, and which, while pretending to be but a catalog of specimens for sale, is actually a study abounding with generic and specific descriptions, the Autikon Botanikon, is never cited in the Kew Index. The total disregard given it by its contemporaries is well illustrated by the fact that in his obituary account of Rafinesque in the American Journal of Science and Arts (**40**: 221–241. 1841). Professor Asa Gray seems not to have been aware of its existence.

Posterity is better able to do justice to Rafinesque than were those of his own time, for now we have the sum of his works before us, and the science of the present day enables us to be certain of the identity of much that was sketchily or partially described therein. By any code of nomenclature his names must be accounted for, and until those conversant with our eastern flora patiently analyze the hundreds of descriptions he has left, there will always be the possible threat of changes in our current specific or generic names. The day is over-due for such an analysis and the writer would tell any doubter that, from his own experience

identifying Rafinesque's species of Scrophulariaceae, if you know your species by other as well as by the traditional criteria, the task is not hopeless. Rafinesque had a sanguine, and sadly not unique, faith that all specimens (and likewise all descriptions) which seemed in any way "different" represented distinct species! Also his confidence in his own "natural" classification so often led him astray with respect to affinities that we are many times left blind. It is a tragedy that Rafinesque's herbarium has not survived.

As a first step toward an appraisal of Rafinesque, I should like to have collected the species unrecorded in the Index Kewensis, but such a list with comments would be too long for presentment in this journal. More importance attaches to the knowledge that unused generic names exist. This paper is the first of several in which I shall attempt to record briefly the unrecorded genera of Rafinesque, upon what they are based, and whether the names are available for use. No responsibility is assumed for the identification of any of these and the describer's own statement of their affinity is given for the purpose of enabling any worker to know if a certain genus is, or is not, of the group of his own special interest.

The Autikon Botanikon doubtless contains the majority of Rafinesque's unrecorded names, inasmuch as it is his only large work overlooked. In it all the new genera are described so that the validity of their publication must be recognized by all. Consequently it is important to have these presented. The following list retains the numbers of Rafinesque's series, while for those who may cite these genera from my list I include in parentheses the pages of the original.

15. JUNIA Raf. (p. 6). Type species, *J. triflora* Raf. "Received from Florida, but whether Floridan, Antillan or African I am not sure." Said to be near *Clethra* and *Cyrilla*. Name antedated by *Junia* Adans., 1763.

33. RONCONIA Raf. (p. 9). Type species, *R. triflora* Raf. "(*Ammania auriculata* nonullis). . . . Egypt." Segregate from *Ammania* L.

60. IONDRA Raf. (p. 11). Type species, *Thlaspi arabica* "L.," actually (L.) Vahl, Symb. Bot. **2**: 76. 1791, based upon *Iberis arabica* L., Cent. Pl., **1**: 17. 1755. *Iondra arabica* (L.) Raf. This is considered to be a species of *Aethionema* R. Br., 1812.

63. CARGILA Raf. (p. 11). Type species, *C. dichotoma* Raf. "South America." Near *Melampodium*. Name antedated by *Cargilla* Adans., 1763.

85. TRIMISTA Raf. (p. 12). Type species, *T. levigata* Raf. "Central America. . . . One of the plants blended in *Nyctago jalapa.*"

88. PLETHYRSIS Raf. (p. 13). Type species, *P. glauca* Raf. "Unaka or Iron Mts. of Carolina." Near *Hedyotis.*

89. ANISTELMA Raf. (p. 69). Name substituted for *Stelmanis* Raf. (p. 13), typified by *Oldenlandia glomerata* Michx., Fl. Bor. Am. 1: 83. 1803, of Carolina. Not *Stelmanis* Raf., Fl. Tellur. 2: 47. 1837.

96. MARZARIA Raf. (p. 14). Type species, *Bocconia cordata* W[illd., Sp. Pl. 2: 841. 1799, of China (?)]. *Marzaria cordata* (Willd.) Raf. This name is antedated by *Macleaya* R. Br., 1826.

101. LEVANA Raf. (p. 15). Type species, *L. uniflora* Raf. (= *Vestia lycioides* Willd.) "African." Specimen received by Rafinesque under names "Vestia lycioides," and "Blairia pentandra," but "it is certainly not a *Blairia!*" and "I don't know who established *Vestia.*" Plant evidently *Vestia lycioides* Willd., Enum. Hort. Berol. 208. 1809, from Chile.

120. SHORTIA Raf. (p. 16). Type species, *Arabis dentata* "Nutt.," actually (Torr.) T. & G., Fl. N. Am. 1: 80. 1838, of Kentucky. *Shortia dentata* (Torr.) Raf. This name antedates the well-known genus *Shortia* T. & G., 1842.

121. SEMETUM Raf. (p. 17). Type species, *S. ramosum* Raf. "Florida." Near *Lepidium.*

167. ACTARTIFE Raf. (p. 20). Type species, *A. cuneifolia* Raf. "Florida, found by Baldwin, deemed *B[oltonia] asteroides.*" Near *Boltonia.*

201. EVACTOMA Raf. (p. 23). Type species, *Cucubalus stellatus* [L., Sp. Pl. 414. 1753, of Virginia]. *Evactoma stellata* (L.) Raf.

207. XAMILENIS Raf. (p. 24). Type species, *Silene acaulis* L. [Sp. Pl. ed. II. 603. 1762, of Europe].

208. PLECONAX Raf. (p. 24). Type species, *Silene conica* L. [Sp. Pl. 418. 1753, of Europe].

209. ALIFIOLA Raf. (p. 24). Type species, *A. dichotoma* Raf. "In Kentucky, disc. 1818." Near *Silene.*

211. IXOCA Raf. (p. 25). Type species, *I. tenella* Raf. (= "Silene 4 dentata L."). "Silene quadridentata L.," of the Alps, is evidently intended to be *Cucubalus quadrifidus* L., Sp. Pl. 415. 1753, later called *Silene quadrifida* (L.) L., Syst. Nat. ed. X. 1032. 1762, and *Lychnis quadridentata* Murr., Syst. Nat. ed. XIII. 362. 1774.

233. EXEMIX Raf. (p. 27). Type species, *Lychnis grandiflora* Jacq. [Coll. 1: 140. 1786]. *Exemix grandiflora* (Jacq.) Raf.

241. EBRAXIS Raf. (p. 29). Type species, *Silene antirrhina* L. [Sp. Pl. 419. 1753, of Virginia].

250. IDANTHISA Raf. (p. 31). Type species, *I. ligustrina* Raf. "Probably of E. Indies." Near *Justicia.*

251. RODATIA Raf. (p. 31). Type species, *R. reticulata* Raf. "South America." Sent to Rafinesque as "Justicia formosa."

275. DIPLANDRA Raf. (p. 35). Type species, *Ludwigia decurrens* Walt. [Fl. Carol. 89. 1788, of Carolina.] *Diplandra decurrens* (Walt.) Raf. Name antedated by *Diplandra* Bert., 1830, and *Diplandra* Hook. & Arn., 1837.

281. ADENOLA Raf. (p. 36). Type species, *Jussieua grandiflora* Michx. [Fl. Bor. Am. 1: 267. 1803, of Georgia]. ***Adenola grandiflora*** (Michx.) Raf.

336. BAZINA Raf. (p. 44). Type species, *B. nudiflora* Raf. of Florida (= ***Lindernia grandiflora*** Nutt.).

365. MERLETA Raf. (p. 49). Type species, *M. microphyla* Raf., of Cuba. Near *Croton*.

366. VANDERA Raf. (p. 49). Type species, *V. discolor* (Jal.) Raf., of Cuba. "Croton do Jal. mpt."

367. ALDINIA Raf. (p. 50). Type species, *A. glechomoides* Raf., of Cuba, "Jalambic". Near *Croton*.

368. BANALIA Raf. (p. 50). Type species, *B. muricata* Raf., of Florida. Near *Croton*. This name antedates *Banalia* Moq., 1849.

369. PLEOPADIUM Raf. (p. 50). Type species, *P. ciliatum* Raf., of South America. Near *Croton*.

372. ALLOSANDRA Raf. (p. 51). Type species, *A. verbenifolia* Raf., of Florida. Near *Tragia*.

388. DIPLEINA Raf. (p. 54). Type species, *D. umbellata* Raf., of Siberia. Near *Actaea*.

401. REGGERIA Raf. (p. 55). Type species, *Ornithogalum bohemicum* W[illd., Sp. Pl. 2: 113. 1799, which is there cited to Zauschner, Act. Bohem. 2: 121.] ***Reggeria bohemica*** (Willd.) Raf.

412. GENLISA Raf. (p. 57). Type species, *Scilla bifolia* L. [Sp. Pl. 309. 1753, of Europe.] Name antedated by *Genlisia* Reichenb., 1828, and *Genlisea* A. St. Hil., 1833. ***Genlisa bifolia*** (L.) Raf.

454. LURONIUM Raf. (p. 63). Type species, *Alisma natans* L. [Sp. Pl. 343. 1753, of Europe.] *Luronium natans* (L.) Raf. This name antedates the genus-name *Elisma* Buchen., 1869, based upon the same species.

487. CODOMALE Raf. (p. 67). Type species, *C. purpurascens* Raf., of Sibiria. Near *Convallaria*.

488. TROXILANTHES Raf. (p. 67). Type species, *T. angustifolia* Raf., of Europe. Near ***Convallaria***.

501. LOMAKE Raf. (p. 73). Type species, *L. brachiata* Raf., of Cuba. Near ***Stachytarpheta***.

507. STREBLINA Raf. (p. 74). Type species, *S. denticulata* Raf., of Florida. Near *Nyssa*.

510. TATINA Raf. (p. 75). Type species, *T. parviflora* Raf., of Mississippi. Near *Bumelia*.

538. KONXIKAS Raf. (p. 78). Type species, *K. acuminatum* Raf., of Siberia (?). Near *Lathyrus* and *Clitoria*.

562. MONOSEMEION Raf. (p. 82). Type species, *M. obliquatum* Raf., of North America (?). Near ***Amorpha***.

571. FESTANIA Raf. (p. 84). Type species, *F. nivea* (Collins) Raf., of Africa. "(Rhus do. Coll[ins] herb.)" Near ***Rhus***.

601. SALIUNCA Raf. (p. 87). Type species, *S. plantaginea* Raf., of Europe. Near ***Fedia***.

610. FUISA (p. 88). Type species, *Valeriana rupestris* Pallas, Reise **3**: 266. ***Fuisa rupestris*** **(Pallas) Raf.**

613. RITTERA Raf. (p. 88). Type species, *Valeriana calcitrapa* [L., Sp. Pl. 31. 1753, of Europe]. *Rittera calcitrapa* (L.) Raf. Name antedated by *Rittera* Schreb., 1789.

613. MONASTES Raf. (p. 88). Alternative name for *Rittera* Raf.

664. KOBIOSIS Raf. (p. 94). Type species, *Euphorbia mellifera* [Ait., Hort. Kew. **3**: 493. 1789, of Madeira]. *Kobiosis mellifera* (Ait.) Raf.

681. DEMATRA Raf. (p. 96). Type species, *D. sericea* Raf., of Palestine (= *Euphorbia villosa* Sieber, non Waldstein).

718. BRAXILIA Raf. (p. 102). Type species, *B. parvifolia* Raf., of Labrador and northern Europe (= *Pyrola minor* L.). This name antedates *Erxlebenia* Opiz, 1852.

723. ORTHILIA Raf. (p. 103). Type species, *O. parvifolia* Raf., of Europe (= *Pyrola secunda* L.) This name antedates *Ramischia* Opiz, 1852.

726. ODOSTIMA Raf. (p. 104). Type species, *Pyrola uniflora* L. [Sp. Pl. 397. 1753, of Europe]. Name antedated by *Moneses* Salisb., 1821.

763. PARMENTIERA Raf. (p. 108). Type species, *P. edulis* Raf., of Peru (= *Solanum tuberosum* O[mnes]). A pre-Linnean and horticultural name for the potato. Its publication here was antedated by *Parmentiera* DC., 1838.

763. ARTORHIZA Raf. (p. 138). Alternative name for *Parmentiera* Raf.

765. ANTIMION Raf. (p. 109). Type species, *A. tomentosum* Raf., of Peru. Near *Solanum*.

766. SCUBULON Raf. (p. 109). Type species, *S. incanum* Raf., of Peru. Near *Solanum*.

835. EUHEMUS Raf. (p. 115). Type species, *E. officinalis* Raf., from "Canada to Louisiana" (= *Lycopus virginicus* L.).

851. ATIRBESIA Raf. (p. 117). Type species, *Marrubium peregrinum* L. [Sp. Pl. 582. 1753, of Europe].

887. PERXO Raf. (p. 121). Type species, *Ocimum polystachyon* "Mur.," actually L., Mant. 567. 1771, of India. ***Perxo polystachya*** **(L.) Raf.**

900. FENIXANTHES Raf. (p. 122). Type species, *Salvia splendens* "Hortis," actually Ker-Gawl in Bot. Reg. 687. 1823. *Fenixanthes splendens* (Ker-Gawl) Raf.

916. PELOTRIS Raf. (p. 125). Type species, *Hyacinthus paniculatus* [Lam., Encyc. **3**: 193. 1789, of Europe]. *Pelotris paniculatus* (Lam.) Raf.

946. ANIKETON Raf. (p. 130). Type species, *A. coriaceum* Raf., of Cuba. Near *Smilax*.

952. DILAX Raf. (p. 131). Type species, *D. muricata* Raf., of Florida. Near *Smilax*.

996. ATEVALA Raf. (p. 136). Type species, *A imbricata* Raf., of Africa. Near *Aloe*.

998. KUMARIA Raf. (p. 137). Type species, *K. spicata* Raf., of Africa (= *Aloe retusa* L.). Name antedated by *Kumara* Medic., 1786.

1000. TULISTA Raf. (p. 137). Type species, *Aloe margaritifera* [Burm. f., Fl. Cap. Prod. 10. 1768, of South Africa]. *Tulista margaritifera* (Burm. f.) Raf.

1001. ICMANE Raf. (p. 141). Type species, *I. nerifolia* Raf., of Australia. Near *Hakea*.

1052. NEMELAIA Raf. (p. 144). Type species, *N. laurina* Raf., of Europe (?). Probably of Myrsinaceae.

1063. TARTONIA Raf. (p. 146). Type species, *T. obovata* Raf., of Europe (= *Daphne Tartonraira* L.).

1074. OZANDRA Raf. (p. 148). Type species, *Melaleuca "hyssopifolia* Sm.," evidently *M. hypericifolia* Sm., Trans. Linn. Soc. **3**: 279. 1797, of Australia.

1102. NEVROLIS Raf. (p. 150). Type species, *N. fuscata* Raf., of Borneo or Moluccas (= *Celosia virgata* "Hortis").

1102. LEPIPHAIA Raf. (p. 199). New name for *Nevrolis* Raf., considered too similar to *Nevrilis* Raf., Sylva Tellur., 138. 1838.

1158. TURSITIS Raf. (p. 156). New name for *Elatine* Moench, 1794, not *Elatine* L., 1753. *Tursitis Elatine* (L.) Raf. Name antedated by *Kickxia* Dumort., 1827.

1165. PROBATEA Raf. (p. 157). New name for *Asarina* Moench.

1167. MISOPATES Raf. (p. 158). Type species, *Antirrhinum Orontium* L. [Sp. Pl. 617. 1753, of Europe]. *Misopates Orontium* (L.) Raf.

1168. TERMONTIS Raf. (p. 158). Type species, *T. racemosa* Raf. of Europe (= *Antirrhinum majus* L.). Not *Termontis* Raf., Chl. Aetn. 5. 1813.

1171. BUCRANION Raf. (p. 159). Type species, *B. spicatum* Raf., of Africa (?). Near *Antirrhinum*.

1172. ANTRIZON Raf. (p. 159). Type species, *A. tenuifolium* Raf., of Sibiria (?). Near *Antirrhinum*.

1227. DASIPHORA Raf. (p. 167). Type species, *D. riparia* Raf., of Eurasia (= *Potentilla fruticosa* L.).

1269. STREPTILON Raf. (p. 173). Type species, *S. odoratum* Raf., of Europe (= *Geum urbanum* L.).

1379. ZELIAUROS Raf. (p. 184). Type species, *Z. repens* Raf., of "Spain or Maroco?" Near *Veronica*.

1400. IPOSUES Raf. (p. 186). Type species, *I. obovata* Raf., of Asia. Near *Erica* or *Menziesia*.

1401. SMIDETIA Raf. (p. 187). New name for *Schmidtia* Tratt. ("*Schmiedtia* Tratenick").

1402. RHIZAKENIA Raf. (p. 188). Type species, *R. ovata* Raf., from "New England to Florida." Near *Pilularia*, *Isoetes*, etc.

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INDEX TO AMERICAN BOTANICAL LITERATURE

1917–1921

The aim of this Index is to include all current botanical literature written by Americans, published in America, or based upon American material; the word America being used in the broadest sense.

Reviews, and papers that relate exclusively to forestry, agriculture, horticulture, manufactured products of vegetable origin, or laboratory methods are not included, and no attempt is made to index the literature of bacteriology. An occasional exception is made in favor of some paper appearing in an American periodical which is devoted wholly to botany. Reprints are not mentioned unless they differ from the original in some important particular. If users of the Index will call the attention of the editor to errors or omissions, their kindness will be appreciated.

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Acqua, C. The dynamics of plant respiration. Sci. Am. Mo. **3**: 28–30. Ja 1921.

Adams, C. C., Burns, G. P., Hankinson, T. L., Moore, B., & Taylor, N. Plants and animals of Mount Marcy, New York. Ecology **1**: 71–94. *pl. 2* + *f. 1–14*; 204–233. *f. 15–20*; 274–288. *f. 21, 22.* 1920.

Adams, J. F. *Darluca* on *Peridermium Peckii*. Mycologia **12**: 309–315. *pl. 21.* 27 D 1920.

Adams, J. F., & Russell, A. M. *Rhizopus* infection of corn on the germinator. Phytopathology **10**: 535–543. *f. 1–6.* D 1920.

Anthony, R. D. Asexual inheritance in the violet. New York Agr. Exp. Sta. Bull. 76: 3–55. Mr 1920.

Ashe, W. W. Notes on the trees and shrubs of eastern North America. Bull. Torrey Club **47**: 581, 582. 28 D 1920.
Includes *Azalea neglecta*, sp. nov., from Carolina.

Bailey, I. W. The cambium and its derivative tissues, II. Size variations of cambial initials in gymnosperms and angiosperms. Am. Jour. Bot. **7**: 355–367. *f. 1–3.* 7 D 1920.

Bailey, I. W. Some relations between ants and fungi. Ecology **1**: 174–189. *pl. 5–7.* Jl 1920.

Barbour, W. R. Argentine and Paraguay forest conditions. Jour. Forestry **18**: 823–830. D 1920.

Bastin, S. L. Giving plants medicine. Sci. Am. Mo. **3**: 62. Ja 1921.

Blakeslee, A. F. A dwarf mutation in *Portulaca* showing vegetative reversions. Genetics **5**: 419–433. *f. 1.* Jl 1920.

Brainerd, E., & Peitersen, A. K. Blackberries of New England—their classification. Vermont Agr. Exp. Sta. Bull. 217: 5–84. *pl. 1–36.* Je 1920.
Includes 2 new hybrids.

Britton, N. L. Investigation of the flora of northern South America. Science II. **53**: 29, 30. 14 Ja 1921.

Brooks, C., Cooley, C. S., & Fisher, D. F. Diseases of apples in storage. U. S. Dept. Agr. Farmers' Bull. 1160: 3–24. *f. 1–26.* S 1920.

Brush, W. D. Utilization of sycamore. U. S. Dept. Agr. Bull. 884: 1–24. *pl. 1–4* + *f. 1–3.* 12 O 1920.

Burkholder, W. H. The effect of two soil temperatures on the yield and water relations of healthy and diseased bean plants. Ecology **1**: 95–112. *f. 1.* Ap 1920.

Burns, G. P. Eccentric growth and the formation of redwood in the main stem of conifers. Vermont Agr. Exp. Sta. Bull. 219: 3–16. *pl. 1–4* + *f. 1–10.* Je 1920.

Campbell, D. H. Some botanical and environmental aspects of Hawaii. Ecology **1**: 257–269. O 1920.

Cannon, W. A. Relation of the rate of root growth in seedlings of *Prosopis velutina* to the temperature of the soil. Carnegie Inst. Washington Year Book **16**: 84. 1917.

Cannon, W. A. Root-growth of *Prosopis velutina* and *Opuntia versicolor* under conditions of a small oxygen-supply in the soil. Carnegie Inst. Washington Year Book **16**: 82, 83. 1917.

Chamberlain, C. J. Grouping and mutation in *Botrychium.* Bot. Gaz. **70**: 387–398. *f. 1–11.* 24 N 1920.

Chardon, C. E. A list of the pyrenomycetes of Porto Rico collected by H. H. Whetzel and E. W. Olive. Mycologia **12**: 316–321. 1920.

Christensen, C., & Skottsberg, C. The Pteridophyta of the Juan Fernandez Islands. Nat. Hist. of Juan Fernandez and Easter Isl. **2**: 1–46. *pl. 1–5* + *f. 1–7.* 1920.

Clute, W. N. Plant names and their meanings. Flower Grower **7**: 196–202. D 1920.

Clute, W. N. The rarest American plant. Am. Bot. **26**: 127–129. N 1920.
Sphaeralcea remota (Greene) Fernald, of Illinois.

Clute, W. N. The toad lily, *Tricyrtis hirta*. Am. Bot. **26**: 138–140. N 1920.

Coulter, M. C. Origin of mechanism of heredity. Bot. Gaz. **70**: 459–464. 30 D 1920.

Coville, F. V. The influence of cold in stimulating the growth of plants. Jour. Agr. Research **20**: 151–160. *pl. 20–35*. 15 O 1920.

Cummings, M. B., & Jones, C. H. The aerial fertilization of plants with carbon dioxid. Vermont Agr. Exp. Sta. Bull. 211: 1–56. *pl. 1–8*. My 1918.

Dachnowski, A. P. Correlation work in peat-land problems. Bot. Gaz. **70**: 453–458. 30 D 1920.

Davis, B. M. The problem of the introductory course in botany. Science II. **52**: 597–599. 24 D 1920.

Dickson, B. T. *Sclerotinia* wilt of greenhouse tomatoes. Phytopathology. **10**: 500, 501. *f. 2*. 1920.

Dickson, B. T. Stem-end rot of greenhouse tomatoes. Phytopathology **10**: 498–500. *f. 1*. 1920.

Dixon, H. N. Contributions to Antarctic bryology. Bryologist **23**: 65–71. *pl. 4*. 2 D 1920.
Includes 3 new species.

Ducke, A. Pajurá e oity-coró. Arch. Mus. Nac. Rio Janeiro 22: 63–68. 1919. [Illust.]
Includes *Couepia rufa* and *Lucuma speciosa*, spp. nov.

Durrell, L. W. A preliminary study of the purple leaf sheath spot of corn. Phytopathology **10**: 487–495. *f. 1–6*. 23 N 1920.

Edwards, J. G. Flower and seed of *Hedyosmum nutans*. Bot. Gaz. **70**: 409–424. *pl. 34–36*. 30 D 1920.

Fernald, M. L. *Rubus recurvicaulis* Blanchard, var. *armatus*, n. var. Rhodora **22**: 168. 7 D 1920.

Folsom, D. Potato mosaic. Maine Agr. Exp. Sta. Bull. 292: 157–184. *f. 28–30*. Au 1920.

Forsaith, C. C. Anatomical reduction in some alpine plants. Ecology **1**: 124–135. *pl. 3, 4*. Ap 1920.

Free, E. E. Imbibition of gelatine and agar gels in solution of sucrose and dextrose. Carnegie Inst. Washington Year Book **16**: 66. 1917.

Friesner, R. C. Daily rhythms of elongation and cell division in certain roots. Am. Jour. Bot. **7**: 380–406. *pl. 24, 25*. 7 D 1920.

Gleason, H. A. The botanical gardens of New York. Sci. Am. Mo. **3**: 24–27. Ja 1921.

Gleason, H. A. The *Iris* collection at the New York Botanical Garden. Flower Grower **8**: 10, 11. Ja 1921.

Grant, C. V., & Hansen, A. A. Poison ivy and poison sumac and their eradication. U. S. Dept. Agr. Farmers' Bull. 1166: 3–16. *f. 1–6.* O 1920.

Grier, N. M. Light correlated variations of the sterile stem of *Equisetum sylvaticum.* Rhodora **22**: 165–167. 7 D 1920.

Haining, H. I. Development of embryo of *Gnetum.* Bot. Gaz. **70**: 436–445. *pl. 39–41* + *f. 1.* 30 D 1920.

Hansen, A. A. Chicory control and eradication. U. S. Dept. Agr. Circ. 103: 2–4. *f. 1.* S 1920.

Hansen, A. A. The hawkweeds or paintbrushes. U. S. Dept. Agr. Circ. 130: 3–7. *f. 1, 2.* O 1920.

Hardy, M. E. Christmas roses. Am. Bot. **26**: 125–127. N 1920.

Harland, S. C. Inheritance of certain characters in the cowpea. Jour. Genetics **10**: 193–205. O 1920.

Harland, S. C. Inheritance in *Dolichos Lablab*, L. Part I. Jour. Genetics **10**: 219–226. O 1920.

Harland, S. C. Inheritance in *Ricinus communis*, L. Part I. Jour. Genetics **10**: 207–218. O 1920.

Harper, R. M. The limestone prairies of Wilcox County, Alabama. Ecology **1**: 198–203. *f. 1, 2.* Jl 1920.

Harper, R. M. Some relations between soil, climate, and civilization in the southern Red Hills of Alabama. So. Atl. Quarterly **19**: 201–215. Jl 1920.

Henry, J. K. *Ribes divaricatum* × *Ribes Lobbii.* Can. Field Natur. **33**: 94. N 1919.

Holm, T. A morphological study of *Cicer arietinum.* Bot. Gaz. **70**: 446–452. *pl. 42–44.* 30 D 1920.

Holm, T. Types of Canadian *Carices.* Can. Field Natur. **33**: 72–77. O 1919.

Hotson, J. W. Colear-rot of apple trees in the Yakima Valley [Washington]. Phytopathology **10**: 465–486. *f. 1–15.* 23 N 1920.

Howe, M. A. Tertiary calcareous algae from the islands of St. Bartholomew, Antigua, and Anguilla. Carnegie Inst. Washington, Publ. 291: 9–19. *pl. 1–6.* 17 O 1919.

Includes descriptions of four new species, *Archaeolithothamnum affine*, *Lithothamnium concretum*, *Lithophyllum homogeneum*, and *Lithophyllum* (?) *molare*, and notes on *Lithoporella melobesioides.*

NEOMILLSPAUGHIA PANICULATA (DONN. SM.) BLAKE

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A study of the structure of the stomata of two species of Citrus in relation to citrus canker

FORMAN T. MCLEAN

(WITH ONE TEXT FIGURE)

There have been many conjectures regarding the causes of differences in resistance of different plants to fungous and bacterial diseases. Usually these differences can not be correlated with any easily recognized characters of the plants in such a way that a definite character may be associated with the disease resistance. The stomatal structure, however, appears to yield such a character in certain of the species of *Citrus* in their relations to citrus canker (*Pseudomonas citri* Hasse).

Marked differences have been observed in the various species and cultivated varieties of *Citrus* in their resistance to canker. Certain of the mandarin varieties, notably "Szinkum," are very resistant, while grapefruit is highly susceptible, as clearly shown by Lee.* It has further been shown by Peltier† and by Lee‡ that all species of *Citrus* and most of the related genera of Rutaceae can be successfully inoculated with canker by pricking the leaves. This seems to indicate that the resistant sorts that can be thus

* Further data on the *Citrus* canker affection of *Citrus* species and varieties at Lamao. Philippine Agr. Rev. **11**: 200–206. 1918.

† Susceptibility and resistance to *Citrus* canker of the wild relatives, *Citrus* fruits and hybrids of the genus *Citrus*. Jour. Agr. Research **14**: 337–357. 1918.

‡ Further data on the susceptibility of rutaceous plants to *Citrus* canker. Jour. Agr. Research **15**: 661–666. 1918.

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inoculated have internal tissues susceptible to canker, but into which canker cannot ordinarily penetrate. Their resistance is believed to be due to differences in the structure of the stomata.*

The present paper gives a comparison of the stomatal structures of two kinds of *Citrus*; one resistant to canker in the manner mentioned above and the other susceptible. For this purpose the Szinkum mandarin (*Citrus nobilis* var. *Szinkum*) was chosen as a highly resistant sort, and a seedling of the Florida grapefruit (*C. grandis*) was chosen as an example of a susceptible sort. These sorts belong to closely related species, they differ comparatively little in leaf morphology, and therefore such differences as are noted in the stomata are the more likely to be directly related to their canker resistance or susceptibility.

PROCEDURE

Young leaves two thirds of their mature size were gathered from the plantation at the College of Agriculture, University of Philippines, on April 10, 1920, and were preserved in alcohol of about 80 per cent concentration. Only the young leaves were used in this study, because the older leaves are no longer susceptible to canker infection in either species, and the old leaves are exceedingly difficult to section for microscopical study. The sectioning and structural study was carried out at the New York Botanical Garden during June, 1920.

Thin slices were cut with a razor parallel to the upper and under surfaces of the leaves. Those from the upper surface showed no stomata. The sections from the under surface were mounted, partly with the cuticle uppermost and partly with the cuticle below. Cross sections were also made of the leaves parallel to their margins. Free-hand sections were found to be the most satisfactory. Imbedding in paraffin was also tried, but the waxy portion was apparently removed from the leaves or rendered transparent by this treatment.

The stomata of the two species were found to be similar in size, general form and mechanism of opening and closing. They are

* The opinion has been expressed that this resistance is due to the epidermis, and evidence in support of this view is given in a paper to be published by Lee and the writer on the resistance of *Citrus nobilis* to *Citrus* canker, with a suggestion for the production of resistant varieties.

both similar to the *Achellea* type described by Copeland.* They differ from this type in having no thickening of the inner half of the ventral wall, and in having no ridge of exit. The general appearance of the stomata of each sort is shown by drawings made under camera lucida (Fig. 1). The stomata were all closed, on account of the treatment with alcohol, except for a few rigid stomata which remained open. The drawings are of closed stomata and therefore represent the minimum widths of aperture.

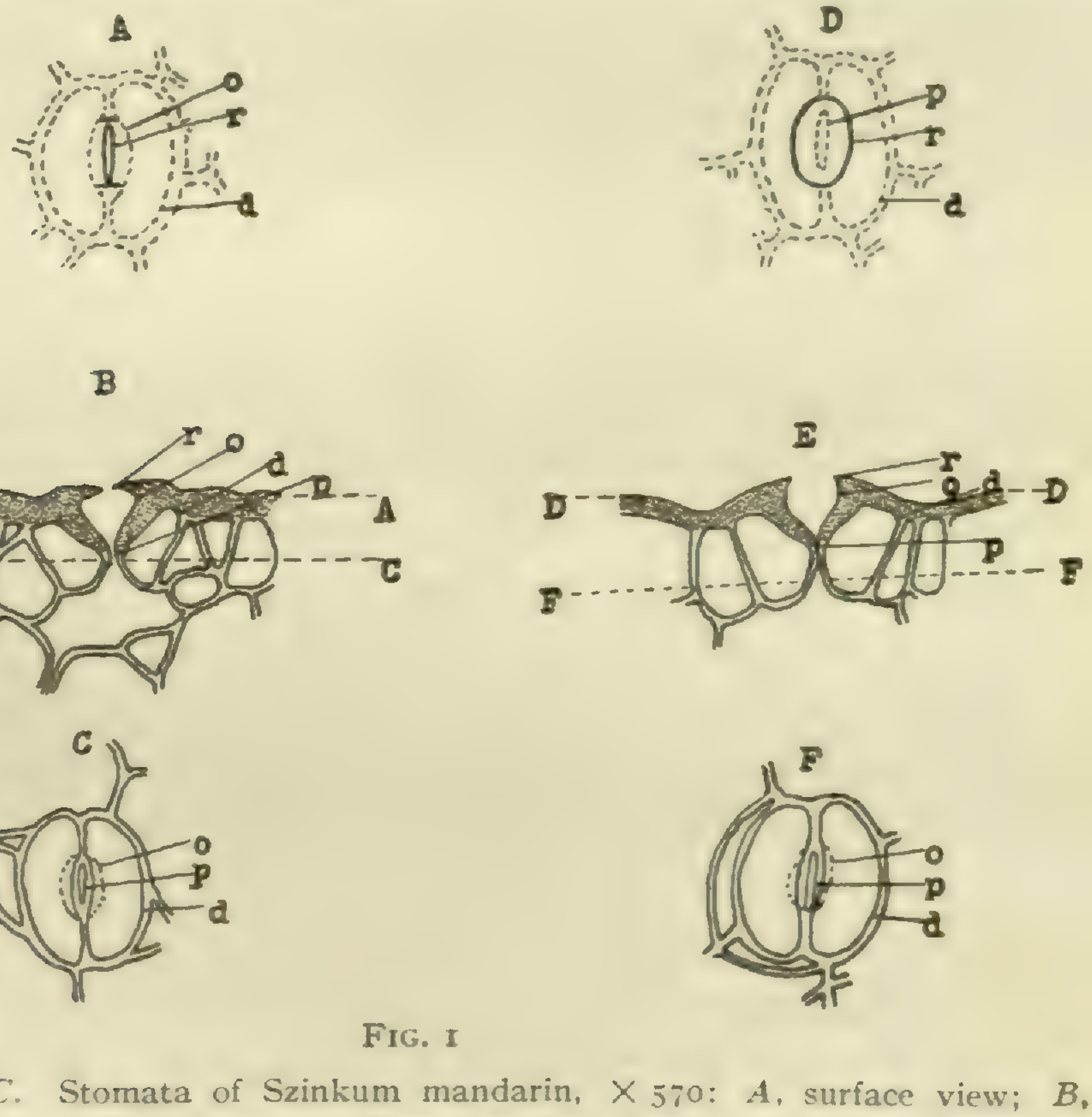

Fig. 1

A, *B* and *C*. Stomata of Szinkum mandarin, × 570: *A*, surface view; *B*, median cross section; *C*, under view. Showing ridge of entrance (*r*); outer chamber (*o*); pore (*p*); and dorsal wall of guard cells (*d*).

D, *E* and *F*. Stomata of Florida seedling grapefruit, × 570, showing same parts as in *A*, *B* and *C*.

The surface views (Figs. 1, *A*, and 1, *D*) show the ridge of entrance, *r*, to be extremely narrow in the Szinkum mandarin, and to be broadly oval in the Florida seedling grapefruit. This difference was found to be constant and very striking in all of the material examined. The average dimensions of the opening in the cuticle surrounded by the ridge of entrance in the Szinkum

* The mechanism of stomata. Ann. Bot. **16**: 342, *f. 15–17*. 1902.

mandarin were 6 μ in length and 0.6 μ in width. These dimensions were very uniform, the extreme lengths being 5 and 7 μ, and the extreme widths 0.5 and 1.5 μ. Therefore twenty-five measurements were deemed sufficient to give a satisfactory average. Sixty corresponding measurements of Florida seedling grapefruit stomata gave an average length of the opening of 9.8 μ, and a width of 6.6 μ. The extreme lengths were 7 μ and 15 μ, and the extreme widths 5 μ and 11 μ. Thus the narrowest opening in the case of Florida seedling grapefruit (5 μ) was more than three times as wide as the widest in Szinkum mandarin (1.5 μ). By focusing downward, the outlines of the guard cells become visible and are shown at *d* in both Figs. 1, *A*, and 1, *D*. In addition, the outline of the wall of the outer chamber is shown at *o* in 1, *A*, and the outline of the pore, *p*, is shown in 1, *D*.

The parts shown in the median cross sections (FIGS. 1, *B*, and 1, *E*) are labelled to correspond to those described above. The positions of the views shown in 1, *A* and 1, *D*, are indicated by the horizontal lines *AA* and *DD*, and the positions of the FIGS. 1, *C*, and 1, *F*, are shown in a similar manner. The shaded portions of these drawings show the portions of the cell walls which are cutinized. The most prominent differences between the two species is again seen to be the ridge of entrance, *r*, which is elongated, projecting over the outer chamber in the case of Szinkum mandarin. In the Florida seeding grapefruit the ridge of entrance is so short that its inner walls are nearly perpendicular, even in the closed stoma, and assume a more spread position in the open stoma. Another feature of interest, though common to both, is the extension of the cutinized tissue along the vertical walls of the guard cells down to the pores.

The under views (FIGS. 1, *C*, and 1, *F*) show clearly that the size of the pore, *p*, is approximately the same in the closed stomata of both species.

The main differences in the two species are, then, in the size of the opening in the cuticle, and in the shape of the ridge of entrance, which bounds this opening. The opening is much larger in the grapefruit than in the mandarin, and the ridge of entrance has its inner walls more nearly perpendicular to the leaf surface. The bearing of these differences upon the resistance to citrus canker will now be considered.

Canker is caused by a bacterium which is motile in water, but entirely passive in air. It is believed that it cannot attack or even by its own activity traverse dry cutinized or waxy cell walls of *Citrus*. The outer walls in both of the species studied are cutinized and normally dry, except when moistened by rain or dew. This is true also of the walls of the outer chambers of the stomata, which are likewise cutinized, as shown by the cross sections of both species studied (Figs. 1, *B*, and 1, *E*). Granting the above to be true, the bacteria can only penetrate to the uncutinized cells of the air spaces inside the leaves in continuous films of water. In intact *Citrus* leaves these can only form through the stomatal openings.

If a *Citrus* leaf of either of the sorts studied is immersed in water and studied under the microscope, air bubbles are found in the stomatal openings. In cross sections these bubbles are seen to extend to the ridge of entrance of the stoma. Thus when a water film is formed over a *Citrus* leaf, this film is held outside of the stomatal openings by the ridges of entrance. With the swaying of the leaves in the wind and with changes in temperature of the air inside the leaves, there are variations in the pressure against the water films covering the stomata, such that there will be a tendency for the water covering the outer surface of the leaf to be drawn into the intercellular spaces.

It will require less pressure to drive the water film inward through a wide aperture with nearly parallel walls, such as form the sides of the outer portion of the outer chamber of the Florida seedling grapefruit, than will be required to drive a water film past a narrow opening, along receding walls, such as form the outer portion of the outer chamber of the stomata of the Szinkum mandarin. Therefore, assuming that a certain minimum pressure is necessary to drive water into the stomata of grapefruit and thus establish a passageway for the entrance of bacteria, then a much greater pressure will be required to accomplsh the same result in the case of Szinkum mandarin. Once water has passed the widest part of the outer chamber, it will then contract its air-water film as it approaches the pore, and surface tension will then accelerate instead of retard the process. When water has passed through the pore, it is then in contact with moist, un-

cutinized cell-walls, and if the bacteria penetrate by means of continuous water from the surface of the leaf to this point, they appear then to be able to persist and develop in most *Citrus* species, as shown by the inoculation experiments of Lee.

The differences in stomatal structure observed in the two kinds of *Citrus* here studied thus are of such a character as to account satisfactorily for the observed difference in their resistance to canker. Field observations and inoculation experiments with *Citrus* canker show that many of the other *Citrus* species and varieties possess resistance to canker of the same general character as that of the Szinkum mandarin but differing in degree. It may be that these other resistant and partially resistant sorts may show structural characters also resembling the Szinkum mandarin. Further study of stomatal structure and canker resistance among the Rutaceae is therefore desirable.

The writer wishes to express his thanks to Dr. N. L. Britton and his associates at the New York. Botanical Garden, particularly Dr. A. B. Stout, for their kindness in furnishing laboratory facilities and valuable suggestions during this study.

SUMMARY

1. Szinkum mandarin, which is resistant to *Citrus* canker, and Florida seedling grapefruit, which is susceptible, are compared, and from a review of previous studies, their difference in resistance is believed to be due to a difference in the character of the stomata.

2. Both sorts have stomata of about the same size and type, differing mainly in the ridge of entrance, which is broad in the mandarin variety, overarching the outer chamber and forming a narrow external opening. In the grapefruit variety it is narrow, making the upper part of the walls of the outer chamber nearly parallel and affording a large opening.

3. These differences are such as to practically exclude water from the stomata of the mandarin, whereas it can more readily enter those of the grapefruit.

4. The exclusion of water is sufficient reason to account for the resistance of *Citrus* varieties to canker, since the canker bacteria are motile when in water but not when dry.

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Taxilejeunea pterogonia and certain allied species*

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(WITH PLATE 2 AND TWENTY-TWO TEXT FIGURES)

The genus *Taxilejeunea* includes some of the largest and most conspicuous of the Lejeuneae with bifid underleaves. Some of the species abound in tropical regions, especially in mountainous localities, and sometimes form broad mats, with or without admixture, on rocks, banks and other suitable substrata. The color is usually a pale yellowish or whitish green, contrasting with the surrounding vegetation. In spite of their large size the plants give an impression of great delicacy. When dry the leaves tend to roll themselves about the stem but, when moist, spread out more or less widely. The lobules, when normally formed, are inflated and show a hyaline papilla at the base of the apical tooth, agreeing in this respect with *Lejeunea*, *Rectolejeunea*, *Pycnolejeunea* and other genera of the Lejeuneae Schizostipae. Unfortunately the lobule is often reduced to a minute basal tooth and fails to exhibit any distinctive features. The underleaves are unusually well developed and sometimes approach or even equal the leaves in size; in other cases they are distinctly smaller.

One of the most distinctive features of the genus is found in the branches which bear the female inflorescences. In typical cases these are short and have distinctly smaller leaves than the stem. The female inflorescence invariably innovates, commonly on one side but occasionally on both, and the innovations are usually short and soon brought to an end by another inflorescence. In this way more or less complicated branch-systems of a cymose character are formed. In many cases the branch-system forms a distinct sympodium with the inflorescences ranged along its upper side. In some of the species which have been referred to *Taxilejeunea*, the described conditions are not clearly exhibited.

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* Contribution from the Osborn Botanical Laboratory.

The female inflorescence, for example, may be borne on a long branch with large leaves, or the innovation of the first inflorescence formed may be sterile. In such cases the systematic position may be one of great uncertainty.

The bracts in *Taxilejeunea* tend to be smaller and narrower than the stem leaves, and the lobules, which are always much smaller than the lobes, are often reduced to vague basal folds, which are scarcely apparent when the bracts are spread out flat. In other cases the apices of the bracts are distinct, and much variation is sometimes found even in a single species. The bifid bracteoles are usually broader than the bracts and often equal them in length. The perianths exhibit great diversity in the different species and considerable variation in a single species is sometimes encountered. The lower part is almost always terete, and this condition may extend throughout the length of the organ, being evident even in the inflated apical portion. In other cases the perianth is five-keeled, the keels extending to below the middle or restricted to the upper part. The keels, in turn, may be smooth or variously toothed and winged. In old and battered perianths the true features are sometimes greatly obscured.

The species discussed in the present paper are all typical members of the genus. They all show leaves which are cordate or auriculate at the base, more or less sharp-pointed at the apex, crenulate throughout and often vaguely toothed in the apical portion; and their underleaves are large, cordate or auriculate at the base and shortly bifid. They are all further distinguished by their sharply five-keeled perianths, the keels in the first three being more or less distinctly winged and toothed. In the fourth species, which is clearly a close ally of the others, the keels are smooth or vaguely crenulate.

1. TAXILEJEUNEA PTEROGONIA (Lehm. & Lindenb.) Schiffn.

Jungermannia pterogonia Lehm. & Lindenb. in Lehmann, Pug. Plant. **6**: 44. 1834.

Omphalanthus pterogonius Lehm. & Lindenb. in G. L. & N. Syn. Hep. 306. 1845.

Omphalanthus subalatus Lindenb. & Gottsche in G. L. & N. Syn. Hep. 747. 1847.

Lejeunea (Taxi-Lejeunea) pterogonia Spruce, Trans. Bot. Soc. Edinburgh **15**: 216. 1884.

Taxilejeunea pterogonia Schiffn. in Engler & Prantl, Nat. Pflanzenfam. **1**[3]: 125. 1895.

Pale green, often becoming yellowish or brownish with age, growing in loose mats and often mixed with other bryophytes: stems mostly 0.15–0.2 mm. in diameter, irregularly and usually sparingly branched, the branches obliquely to widely spreading, sometimes long and similar to the stem but often short, invariably so if sexual: leaves loosely imbricated, the lobe obliquely spreading, plane to strongly convex, scarcely falcate, ovate, mostly 0.8–1 mm. long and 0.55–0.75 mm. wide when well developed, dorsal margin arching across the stem and conspicuously auriculate at the base, slightly curved in the outer part, ventral margin slightly curved and forming a wide angle with the keel, apex acute or apiculate and often tipped with a row of two cells, margin slightly and minutely crenulate from projecting cells, sometimes with one or two larger and sharper teeth in the vicinity of the apex; lobule when well developed inflated throughout, ovoid, about 0.15 mm. long and 0.1 mm. wide, keel straight to slightly arched, free margin involute to beyond the apex, sinus very short, shallowly lunulate (in spread out lobules), apical tooth an almost straight, scarcely projecting rounded cell; lobule often imperfectly developed but usually evident; cells of lobe about 16 μ in width along the margin, 32 x 24 μ in the middle, and 40 x 24 μ at the base, thin-walled but with distinct (and sometimes confluent) trigones and intermediate thickenings, the latter sometimes two in number in a long lateral wall, cuticle covered over with exceedingly minute, dot-like verruculae: underleaves loosely imbricated, convex (from below), the lateral margins often more or less involute, orbicular, mostly 0.6–0.9 mm. long, bifid one fourth to one third with a narrow, usually sharp sinus and broad, subacute, often contiguous or overlapping divisions, distinctly auriculate at the base, the auricles usually contiguous or overlapping, margin minutely crenulate throughout as in the leaf-lobes: inflorescence autoicous: ♀ inflorescence usually borne on a very short branch but sometimes on a somewhat elongated branch, innovating on one side, the first innovation usually at once floriferous, the second smoetimes floriferous but more frequently sterile; bracts slightly spreading, scarcely keeled, the lobe straight (not falcate), ovate, mostly 0.55–0.65 mm. long and 0.25–0.3 mm. wide, acute and usually coarsely and irregularly toothed, the teeth sharp or blunt, rarely more than three or four, lobule in some cases distinct, 0.2–0.3 mm. long and 0.07 mm. wide with an acute apex, but usually narrower and sometimes

very indistinct; bracteole slightly connate with the bracts, obovate or oblong, mostly 0.55–0.65 mm. long and 0.35–0.4 mm. wide, bifid about one third with a narrow acute sinus and erect, acute or subacute divisions, the margins crenulate as in the underleaves and often bearing in addition one or two sharp or blunt teeth on the sides; perianth more or less exserted, sometimes for about half its length, broadly to narrowly obovoid, mostly 0.5–1.2 mm. long and 0.35–0.4 mm. wide, cuneate toward the base and truncate at the apex with a short but distinct beak, sharply five-keeled in the upper half or third, the keels more or less distinctly winged and the wings sharply dentate or spinose, the number of teeth or spines on each wing usually from one to four: ♂ inflorescence occupying a short branch or, rarely, a subfloral innovation, apparently never proliferating; bracts mostly in two to six pairs, imbricated, much smaller than the vegetative leaves, strongly inflated, shortly bifid with blunt lobes and a strongly arched keel; antheridia in pairs; bracteole usually single and very small, ovate, bifid about one half with subacute divisions: mature capsule about 0.25 mm. in diameter. [PLATE 2.]

On earth and rocks; widely distributed in the American tropics. The specimens cited include all that the writer has personally examined. Other records for the species are noted in connection with its history.

GUATEMALA: near Coban, Alta Verapaz, February, 1886, *H. von Türckheim II* (specimens determined by Stephani and distributed by Levier; they are unfortunately sterile and therefore somewhat uncertain).

JAMAICA: near Mabess River, April, 1903, *W. R. Maxon 1562;* vicinity of Moody's Gap, September, 1908, *E. G. Britton 916.*

VENZEUELA: Paramo de la Culata, province of Merida, *J. Linden 574* (Mitten Herbarium).

COLOMBIA: Andes of Bogota, *W. Weir* (Mitten Herbarium).

ECUADOR: Canelos, *R. Spruce* (distributed in Hepaticae Spruceanae); Quito, *Jameson* (Mitten Herbarium, under the name *T. chimborazensis* Spruce); near Quito, 1914, *G. Hammond 3* (specimen received from W. Ingham).

PERU: San Miguel, July, 1911, *H. W. Foote* (listed by the writer in Trans. Connecticut Acad. **18**: 315. 1914); same locality, June, 1915, *Cook & Gilbert 1179, 1180;* Torontoy, July, 1915, *Cook & Gilbert 1778.*

BOLIVIA: without collector's name, date or definite locality

(Mitten Herbarium, specimen received from Montagne—labeled "*Omphalanthus debilis* . . . Peruvia"—but presumably collected by D'Orbigny in Bolivia); Yungas, June and July, 1893, *P. Jay 2, 13, 16, 119.*

This interesting species was based on a specimen from Peru in the Kunze Herbarium, neither the collector's name nor the definite locality being mentioned in the original description. This specimen was fortunately fertile and Lehmann and Lindenberg describe the perianth as turbinate and five-angled at the apex, the angles growing out into ciliate crests. Other important characters of their *Jungermannia pterogonia* did not escape them: they call attention to the cordate-ovate leaves, apiculate at the apex and often minutely denticulate in the upper part; to the minute lobules, which they describe as almost obsolete; to the cordate-orbiculate underleaves, acutely and very narrowly "emarginate" at the apex but otherwise entire; to the very short female branches; to the "lanceolate," acute, "denticulate" bracts; and to the bifid, "serrate-denticulate" bracteoles.

In the Synopsis Hepaticarum the arrangement of the perianths in a secund series is emphasized; otherwise the original description is transcribed, almost word for word. In addition to the original Peruvian specimen, however, the authors cite a Mexican specimen under *Omphalanthus pterogonius*, although here again neither the collector's name nor the definite locality is mentioned.

The next allusions in the literature to *T. pterogonia* are apparently in the writings of Gottsche. In his "Mexikanske Levermosser," published in 1863, he refers the Mexican specimens which the Synopsis had included under *O. pterogonius* to *O. subalatus* Lindenb. & Gottsche,* a species based on Mexican material from Mirador, collected by F. Liebmann.† In this species the perianth is described as cylindrical-turbinate and pentagonal at the apex, the angles being "subalate" but smooth. No other differential characters of much significance are brought out. In his chapter on the Hepaticae in Triana and Planchon's "Prodromus Florae Novo-Granatensis," published the following year, Gottsche cites the true *O. pterogonius* from Aserradero and

* Kong. Dansk. Vidensk. Selsk. Skr. V. **6**: 274. 1863.

† G. L. & N. Syn. Hep. 747. 1847.

Cipacon, two stations in the vicinity of Bogota, Colombia, the collector in both instances being A. Lindig.* Here, for the first time, a monoicous inflorescence is ascribed to the species.

Next in order is the full and careful account by Spruce in his "Hepaticae of the Amazon and of the Andes," which appeared in 1884. He emphasizes particularly the cordate or auriculate features of the leaves and underleaves, describing the auricles of the leaves as "rotundo-circinata," and those of the underleaves as "forficato-imbricata." He alludes, moreover, to the small leaves and underleaves of the female branches and states that each innovation bears "only a single row of them below the flower." He describes the leaves as "pauciserrulata" (with about four teeth) in the vicinity of the apex, and implies that the lobule is always very minute. With regard to the bracts he makes no mention of the lobule but states that the lobe varies from oblong to ovate-lanceolate, the upper portion being more or less serrate. The perianth he describes as five-angled in the upper part with winged angles, the wings being extended as "laciniato- ciliatove-cristata" horns. Spruce cites the species from the Pastasa River, Ecuador, *R. Spruce;* from Mount Campana, Peru, *R. Spruce;* and from Caldas, Brazil, *G. A. Lindberg.* He notes also its earlier collection in Peru and Mexico, apparently ignoring Gottsche's statements regarding the Mexican specimens.

It will be seen that definite and well-authenticated records for *T. pterogonia* up to this time are restricted to scarcely half a dozen localities in South America. The researches of Stephani, however, brought a few additions to the list. In his revision of the "Gattung *Lejeunea* im Herbarium Lindenberg." published in 1890, he quotes the species from Peru (the original Kunze specimens) and also from the following stations: Mirador, Mexico, *Liebmann 262, 326;* Merida and Tovar, Venezuela, *Moritz.*† The Mexican specimens represent *Omphalanthus subalatus*, which, in Stephani's opinion, is a form of *O. pterogonius* with entire leaves. He thus differs from Gottsche who found the differential characters in the perianths. Some of the Venezuela specimens are listed in the Synopsis under the name *O. debilis* γ* *columbicus;* the others

* Ann. Sci. Nat. Bot. V. 1: 147. 1864.

† Hedwigia 29: 12, 13. 1890.

bear the incorrect name *O. apiculatus* Gottsche in the Lindenberg Herbarium. Stephani has since cited *T. pterogonia* from Chenim de Carillo, Costa Rica, *Pittier 6064*.* In 1913 he described the habitat of the species as, "*America tropica*, valde communis,"† but this scarcely seems warranted from the scanty records in the literature.

The writer, as already noted, has recently recorded *T. pterogonia* from San Miguel, Peru, but regrets that he has been unable to confirm any of the other published records for the species. The large series of specimens listed above has, however, been available for study and this has included named material from Ecuador in Spruce's Exsiccatae (not alluded to in his book) and named material from Colombia in the Mitten Herbarium. This material and the other specimens listed clearly represent the same specific type.

In describing a variable species it is always difficult to do justice to its range of variability and at the same time to distinguish it clearly from its allies. This is strikingly the case with *T. pterogonia* and other members of this difficult genus. When fertile and well-developed specimens are examined their specific characters seem to be above question, but marked variations are often encountered, even in a single plant, and tend to obscure the specific limitations. These variations affect particularly the size and vigor of the plants, the form and marginal features of the leaf-lobes and underleaves, and the characters derived from the involucral leaves and underleaves. In the case of sterile material a positive determination is always difficult and may be quite impossible.

According to Stephani the stems of *T. pterogonia* sometimes attain a length of 10 cm. In the writer's experience they rarely surpass 4 cm. in length, although a greater development would not be surprising. Stephani's measurements of the leaves and underleaves are likewise a little high and must have been drawn from unusually vigorous plants. According to his description the leaves are 1.67 mm. long and 1.33 mm. wide, while the underleaves measure 1 x 1.33 mm. Spruce gives 1.1 x 1 mm. for the

* Bull. Soc. Roy. Bot. Belgique **31**: 180. 1892.

† Spec. Hepat. **5**: 476. 1913.

leaves and 1–1.1 x 1–1.1 mm. for the underleaves, while the writer's measurements are even lower. In many instances the stems are simple or very sparingly branched until the short sexual branches are formed, but long branches essentially like the stem are not infrequent and sometimes completely change the aspect of a plant.

The earlier writers describe the leaves as semivertical or "subsemivertical," but FIGS. 1–3 show that they spread at an angle of about 45 degrees and that Stephani is correct in describing them as "oblique patula." The same figures show the inconstancy of teeth in the apical region; many of the leaves are entire throughout, except for the very vague marginal crenulations (shown in FIG. 5), and none of the leaves figured show more than two teeth. In rare cases the writer has observed three teeth but never a higher number, although Spruce gives the number of teeth as about four. The basal auricle of the lobe, emphasized by both Spruce and Stephani, is clearly shown in FIG. 3. The published descriptions all insist that the lobule is exceedingly minute and rudimentary, and this is probably its usual appearance. Not infrequently, however, distinctly inflated lobules are present and conform to the type distinctive of the genus. Such lobules are shown in FIGS. 1 and 2, while FIG. 6 shows the apical portion, with its short rounded tooth and proximal hyaline papilla.

The leaf-cells deserve rather more attention than has previously been given them. Spruce describes them as "leptodermes," without mentioning the trigones, while Stephani states merely that the trigones are small. FIG. 4 shows that both trigones and intermediate thickenings are present and that they often show bulging sides. Sometimes the thickenings are less marked than in the cells figured, and the trigones may even show concave sides; but apparently distinct thickenings form a characteristic feature of the cells. Another feature, which earlier writers seem to have overlooked, is found in the dot-like verruculae scattered over the free walls of the cells. They are exceedingly minute, measuring less than a micromillimeter in diameter and can be made out only by careful observation.

The underleaves exhibit in a marked degree the highly arched line of attachment which is characteristic of the more typical

species of *Taxilejeunea*. This is brought out in FIGS. 1 and 2, which likewise show the striking basal auricles. In most cases these are so large that they closely approach each other or even overlap. The single auricle shown in FIG. 8 indicates the vaguely crenulate margin found in the underleaves as well as in the leaves. The apical incisions, as shown in the figures, are sometimes a little deeper than the published descriptions imply, while the lobes are subacute or even subobtuse rather than invariably acute, but these discrepancies are slight and of but little significance.

The branch-system upon which the female inflorescences are borne is less complex and subject to less variability than in many other species. In the majority of cases (see FIG. 1) the branch bears one or two small underleaves, with their corresponding leaves, and then proceeds at once to form an archegonium with its involucral leaves; from the base of the inner bract a subfloral innovation arises and bears a second female inflorescence after producing a single small underleaf and a single leaf. The innovation arising from this second flower is usually sterile and may be very short; sometimes, however, it gives rise to a third inflorescence which in turn gives rise to a sterile innovation. The writer has observed no instance in which more than three inflorescences of successive orders were present on a branch-system, although it would not be surprising if more were occasionally developed. When perianths are present, the system presents the appearance of a short branch with two or three closely approximated perianths along its upper side. Deviatons from this condition are of occasional occurence; sometimes, for example, the original branch bears several to many leaves before its growth is brought to an end by the development of an archegonium; sometimes (see FIG. 2) an innovation will bear two (rarely three) underleaves and three (rarely five) leaves (instead of one of each); sometimes the first inflorescence gives rise to two innovations, each of which is tipped with an archegonium; sometimes a subfloral innovation develops as a male spike. These deviations are not infrequent and probably others could be detected by careful search, and yet the type first described occurs so often that it may be regarded as distinctive of the species.

The bracts and bracteoles represented (FIGS. 9–18) show a

considerable range of variation. FIG. 9 illustrates the first involucre of a branch-system taken from a Peruvian specimen and brings out the fact that there is a slight coalescence between the bracteole and the bracts and also between the bracts themselves. In the bract on the left the basal tooth represents the lobule but the next tooth is even larger and more sharply pointed; the other teeth are much smaller, several of them being nothing more than projecting cells. The other bract shows similar teeth, the lobule (the basal tooth) being much like the others; the bracteole is unidentate on each side. FIGS. 10–12 illustrate the bracts and bracteole of the second inflorescence of the same branch-system; FIG. 13, the bracts and bracteole of the first inflorescence of another branch-system from the same material; FIGS. 14 and 15, one bract and the bracteole of the second inflorescence of this second branch-system; and FIGS. 16–18, the bracts and bracteole of an inflorescence taken from a Jamaican specimen. It is not necessary to describe these in detail, but the unusually large lobule in the left-hand bract of FIG. 13 should be noted and also the approach to an entire condition shown in FIG. 17. There is perhaps a tendency for the first inflorescence of a system to develop more strongly dentate bracts with larger lobules than the succeeding inflorescence or inflorescences, but this tendency is too vague to be insisted upon. Bracts which are absolutely toothless and which show scarcely a sign of a lobule occasionally occur (although none are figured); they are commonly associated with the second or third inflorescence of a systen, but even the first inflorescence sometimes shows bracts of this character.

The perianth is characterized by the dentate to spinose wings borne on its five sharp keels (FIGS. 1, 2 and 19). These wings may be either continuous or once or twice interrupted and rarely exceed ten cells in length or three in width; sometimes a second, less well-developed wing may be found on a single keel. The teeth borne on the margin of the wing vary greatly; from one to four teeth are commonly present and these vary from one to four cells in length and from one to three cells in width at the base; they may therefore be slender cilia, broad triangular lobes, or short slightly projecting cells or groups of cells. The beak is short and relatively broad, consisting of two or three superimposed circles of cells.

2. **Taxilejeunea jamaicensis** sp. nov.

Pale whitish or yellowish green, growing in loose mats and often mixed with other bryophytes; stems mostly 0.15–0.18 mm. in diameter, irregularly but often copiously branched, the branches obliquely to widely spreading, often copiously branched, the branches obliquely to widely spreading, often long and similar to the stem but sometimes with smaller leaves even if not sexual: leaves loosely imbricated, the lobe obliquely spreading, plane to strongly convex, scarcely falcate, ovate, mostly 0.75–1.2 mm. long and 0.5–0.9 mm. wide when well developed, dorsal margin arching across the stem and usually distinctly auriculate at the base, slightly curved in the outer part, ventral margin slightly curved and forming a wide angle with the keel, apex acute or apiculate and often tipped with a row of two cells, margin slightly and minutely crenulate from projecting cells, sometimes with one or two larger and sharper teeth in the vicinity of the apex; lobule inflated throughout, ovoid, about 0.15 mm. long and 0.1 mm. wide when well developed, keel straight to slightly arched, free margin involute to beyond the apex, sinus very short, shallowly lunulate (in flattened out lobules), apical tooth an almost straight, slightly projecting rounded cell; lobule often imperfectly developed and sometimes scarcely evident; cells of lobe about 19 μ wide along the margin, 36 x 27 μ in the middle and 38 x 27 μ at the base, thin-walled but with distinct (and rarely confluent) trigones and intermediate thickenings, the latter very rarely more than one in each wall, cuticle covered over with exceedingly minute, dot-like verruculae: underleaves contiguous to loosely imbricated, convex (from below), the lateral margins often involute, orbicular, mostly 0.6–1 mm. long, bifid one fourth to one third with a narrow, usually sharp sinus and broad bluntly pointed or subacute, often contiguous or slightly overlapping lobes, distinctly auriculate at the base when well developed (but sometimes only cordate or rounded), the auricles often contiguous but rarely overlapping, margin as in the leaf-lobes: inflorescence autoicous: ♀ inflorescence sometimes borne on a very short branch but often on a more or less elongated branch, innovating on one side (or very rarely on both sides), the first innovation often floriferous but rarely immediately so, sometimes sterile (and rarely male), the second and one or more of the succeeding innovations not infrequently floriferous also; bracts slightly spreading, keel rounded, the lobe straight, scarcely if at all falcate, ovate to oblong, mostly 0.6–0.9 mm. long and 0.25–0.4 mm. wide, bluntly pointed to acute, sometimes coarsely and irregularly toothed, sometimes merely sinuate, the teeth when present usually blunt, rarely more than three or four, lobule in some cases distinct even in bracts spread out flat, 0.2–0.25 mm.

long and 0.06–0.09 mm. wide, the apex often discrete and sharp but sometimes scarcely evident; bracteole free or nearly so from the bracts, obovate or oblong, mostly 0.6–0.65 long and 0.35–0.45 mm. wide, bifid one fourth to one third with a narrow subacute to rounded sinus and erect acute or subacute divisions, the margins crenulate as in the underleaves and often bearing in addition a sharp or blunt tooth on one or both sides; perianth more or less exserted, sometimes for about half its length, obovoid, mostly 0.65–0.9 mm. long and 0.25–0.4 mm. wide, cuneate toward the base and truncate at the apex with a short but distinct beak, five keeled in the upper fourth or third, the keels very variable, sometimes rounded and sometimes sharp, in the latter case often winged, the wings sometimes narrow and interrupted, sometimes broader and continuous, entire or bearing one or two sharp or blunt marginal teeth: ♂ inflorescence occupying a short branch or, rarely, a subfloral innovation, very rarely terminating an elongated branch, apparently never proliferating; bracts, antheridia, and bracteoles as in *T. pterogonia*. [TEXT-FIGS. 1–11.]

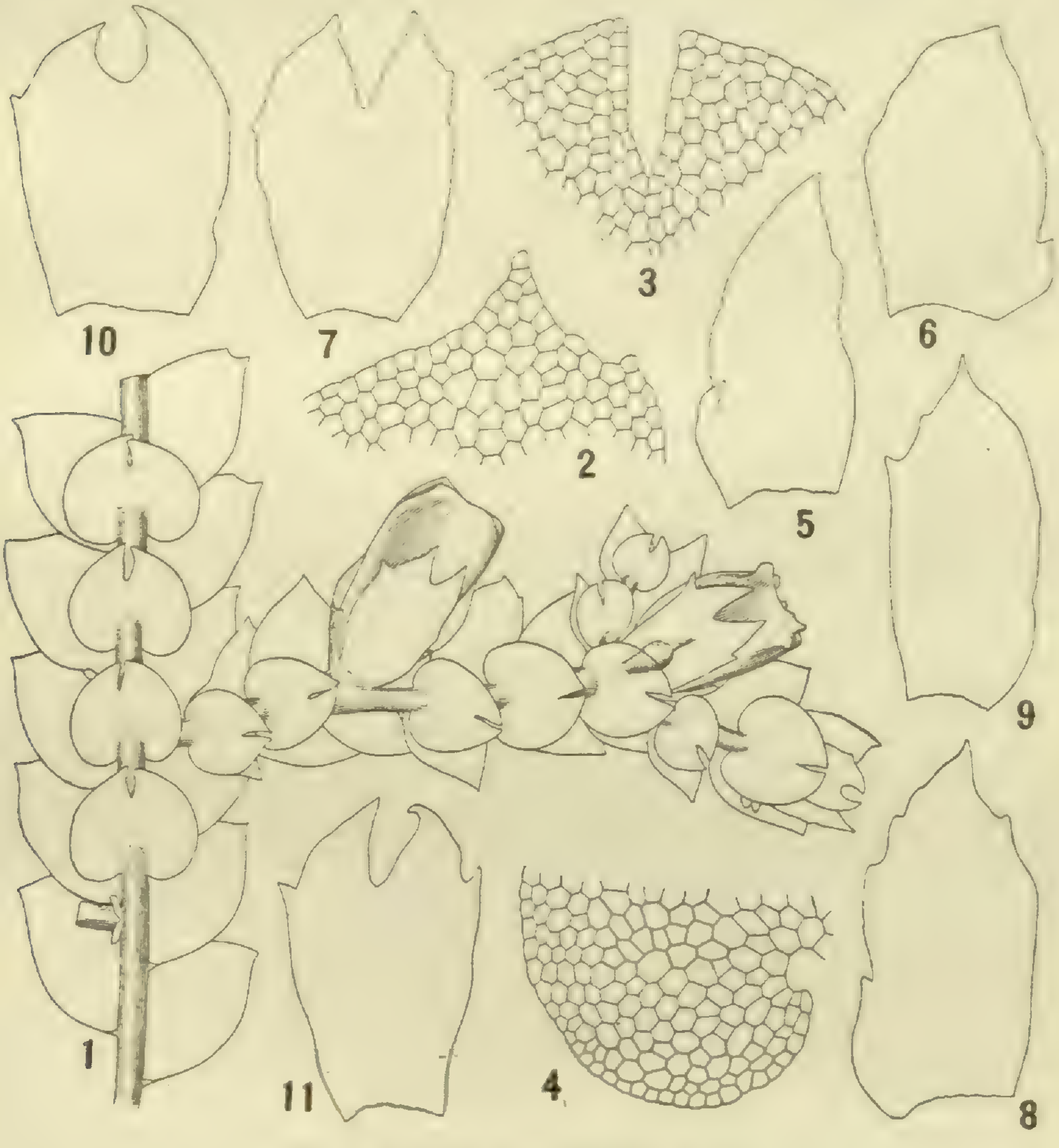
On banks and rocks, known with certainty only from Jamaica. The following specimens have been examined:

JAMAICA: without definite locality, *O. Swartz* (specimen labeled "*Jungermannia debilis*" in the Mitten Herbarium, received from the Hooker Herbarium); Cinchona, January, 1903, *L. M. Underwood 241;* same locality, October, 1908, *E. G. Britton 1062;* trail from Cinchona to Morce's Gap, January and February, 1903, *L. M. Underwood 255, 1231;* Clyde River Valley, January, 1903, *L. M. Underwood 402;* same locality, July, 1903, *A. W. Evans 3, 8, 9, 13, 18;* same locality, August, 1906, *A. W. Evans 357;* Morce's Gap and vicinity, February, 1903, *L. M. Underwood 1408, 1420;* same locality, May, 1906, *D. S. Johnson 49;* Mount Diabolo, April, 1903, *L. M. Underwood 1847;* Hardware Gap and vicinity, April, 1903, *L. M. Underwood 2250;* same locality, July, 1903, *A. W. Evans 205* in part; same general locality, March, 1920, *Maxon & Killip 1267;* St. Catherine's Peak and vicinity, August, 1906, *A. W. Evans 431.*

No. 13, from Clyde River Valley, collected by the writer, may be designated the type.

The most important distinctions between *T. jamaicensis* and *T. pterogonia* are apparently those derived from the female branch-systems. In *T. pterogonia* these usually exhibit but little variation as already brought out, but in *T. jamaicensis* the range

of variability is greater and there seems to be no special type which is more or less closely approximated. In the plant figured (FIG. 1) the branch developed three underleaves (one of which has been dissected away) with the corresponding leaves before



TAXILEJEUNEA JAMAICENSIS Evans

1. Part of a stem showing a female branch-system, ventral view, × 25. 2. Apex of lobe, × 90. 3. Apex of underleaf, × 90. 4. Basal auricle of underleaf, × 90. 5–7. Bracts and bracteole from a single inflorescence, × 45. 8–10. Bracts and bracteola from another inflorescence, × 45. 11. Bracteole from a third inflorescence, × 45. The figures were all drawn from the type specimen.

the first inflorescence; the single innovation of this inflorescence bore three more underleaves with their corresponding leaves and then a second inflorescence with two subfloral innovations; one of the latter was short and sterile, but the other developed a

third inflorescence with a single sterile innovation after bearing two underleaves with their corresponding leaves. A female branch system on another specimen (*Evans 3*) bore eight underleaves before the inflorescence, and the latter showed a single long sterile innovation with sixteen distinct underleaves. Another branch-system on the same specimen bore the first inflorescence after only two underleaves; the single innovation gave rise to eleven underleaves and a male branch before bearing a second inflorescence; and this in turn gave rise to a single long sterile innovation with ten distinct underleaves. These examples, selected more or less at random, will give some idea of the variations encountered and indicate that long branches and long subfloral innovations are of frequent but by no means of constant occurrence.

The other distinctions between *T. pterogonia* and *T. jamaicensis* are likewise associated with the greater variability of the latter species. The characters derived from the leaves, underleaves and floral parts are similar to those of *T. pterogonia* but less definitely realized. In the leaves, for example, the auricles at the base, although often as distinct as in *T. pterogonia*, are sometimes less marked; the thickenings of the leaf-cells tend to be less developed, and the surface-verruculae are often more difficult to demonstrate. The auricles of the underleaves may likewise be very distinct (FIG. 4), but the same specimen (FIG. 1) will often show underleaves which are rounded at the base. In the bracts (FIGS. 5, 6, 8 and 9) the teeth are usually much less distinct, and bracts with entire margins are of more frequent occurrence, while the bracteoles (FIGS. 7, 10 and 11) show no differences of importance. It is in the perianths, however, that the greatest range of variability is met with. Of the perianths figured (FIG. 1) the one at the left is almost beakless and the wings of the angles are reduced to scattered projecting cells; the perianth at the right shows a distinct beak and interrupted wings two cells wide on the two ventral keels, these wings bearing rounded teeth; the lateral and dorsal keels of this same perianth (not clearly shown in the figure) bear very narrow, indistinct and entire wings. In one perianth on another specimen (*Evans 3*) the short wings on the ventral keels run out into sharp points, but the dorsal and lateral keels are scarcely winged at all; in another perianth

on the same stem the wings on the two lateral keels and on one ventral keel run out into points, the dorsal keel and the other ventral keel being almost wingless; in a third perianth on the same stem all five keels bear more or less pointed wings. The perianths described include the most complex wings observed, and it will at once appear that these never exhibit the sharply dentate or ciliate condition so often found in *T. pterogonia*, although the less complex conditions of that species may be approached.

3. **Taxilejeunea densiflora** sp. nov.

Pale yellowish or whitish green, growing in loose mats, pure or in admixture with other bryophytes: stems mostly 0.2–0.25 mm. in diameter, irregularly branched, the branches mostly shorter and with smaller leaves than the stem, usually bearing sexual organs and sometimes more or less subdivided: leaves loosely imbricated, the lobe obliquely spreading, plane to somewhat convex, scarcely falcate, ovate, mostly 1–1.5 mm. long and 0.8–1.2 mm. wide when well developed, dorsal margin arching across the stem and rounded to cordate at the base, slightly curved, ventral margin slightly curved and forming a wide angle with the keel, apex rarely obtuse, mostly acute or apiculate and occasionally tipped with a row of two cells, margin minutely but distinctly crenulate from projecting cells especially toward the apex and occasionally with one or two larger blunt or sharp teeth in this vicinity; lobule inflated throughout, narrowly to broadly ovoid, about 0.15 mm. long and 0.06–0.1 mm. wide when well developed, keel straight to slightly arched, free margin involute to beyond the apex, sinus and apical tooth as in allied species; lobule usually poorly developed; cells of lobe about 23 μ wide along the margin, 44 x 32 μ in the middle and 55 x 34 μ at the base, thin-walled throughout or with minute trigones having concave sides, intermediate thickenings, scarcely or not at all developed, cuticle smooth; underleaves contiguous to loosely imbricated, convex from below, the lateral margins often involute, orbicular, mostly 0.8–1.2 mm. long, bifid one fourth or less with a narrow, usually sharp sinus and broad, acute to obtuse, contiguous or overlapping divisions, cordate to auriculate at base, the auricles sometimes contiguous but rarely if ever overlapping, margin minutely crenulate from projecting cells; inflorescence autoicous: ♀ inflorescences borne on a more or less elongated and usually repeatedly floriferous branch-systems, each subtended by one or, rarely, two innovations, the latter often bearing a second flower after a single vegetative leaf and underleaf, complicated

cymose inflorescences being thus formed; bracts slightly spreading, scarcely keeled, the lobe straight (not falcate), ovate, mostly 0.85–1.1 mm. long and 0.35–0.55 mm. wide, acute and usually irregularly toothed, the teeth small, sharp or blunt, rarely more than three or four and often vague or indistinct, lobule usually indistinct, represented by a short and narrow basal fold, the apex rarely distinguishable but sometimes acute; bracteole free or nearly so from the bracts, ovate to obovoate, mostly 0.7–1 mm. long and 0.45–0.6 mm. wide, bifid about one fourth with a narrow acute sinus and erect, acute lobes, the margins as, in the underleaves, rarely with a median sharp or blunt tooth on one or both sides; perianth more or less exserted, sometimes for about half its length, obovoid and often narrowly so, mostly 0.6–0.75 mm. long and 0.3–0.35 mm. wide, cuneate toward the base and truncate at the apex with a rather long beak, five-keeled in the upper third, the keels sometimes rounded and indistinct but often sharper and more or less distinctly winged, a wing sometimes bearing one or two short and irregular teeth: ♂ inflorescence occupying a short branch, usually arising in a ♀ inflorescence branch-system, sometimes in the form of a subfloral innovation, apparently never proliferating; bracts mostly in one to five pairs, imbricated, much smaller than the vegetative leaves, strongly inflated, shortly bifid with blunt or subacute lobes and a strongly arched keel; antheridia in pairs; bracteole mostly single, very small, ovate bifid about one third with subacute lobes: mature sporophyte about 0.2 mm. in diameter. [TEXT-FIGS. 12–22.]

On wet rocks; range incompletely known. The following specimens have been examined:

JAMAICA: near spring and waterfall, vincinity of Moody's Gap, September, 1908, *E. G. Britton 938;* on wet rocks, Hardware Gap and vicinity, July, 1903, *A. W. Evans 204;* on wet rocks, Doll Wood, August, 1906, *A. W. Evans 485;* on *Asplenium alatum* H. B. K., growing on wet rocks, trail from Morce's Gap to Vinegar Hill, March, 1920, *Maxon & Killip 1318a.*

COLOMBIA: Cerra de Onaca, August, 1898, *H. H. Smith "D."*

Mrs. Britton's specimen from Moody's Gap, Jamaica, No. 938, may be designated the type.

The branch-systems upon which the female inflorescences are borne sometimes attain a high degree of complexity and constitute one of the distinctive features of the species. In their simpler states these branch-stysems resemble those of *T. jamaicen-*

sis, although usually with fewer leaves. One of those examined bore two underleaves with the corresponding leaves and then a perianth with its involucral leaves; the subfloral innovation arising at the base of the inner bract bore a single leaf and underleaf and then a second perianth; this process was repeated twice, the subfloral innovation borne below the last inflorescence being simple and very rudimentary. In this way a one-sided cymose inflorescence was formed with four crowded perianths along its upper side. Similar, relatively simple branch-systems are shown in FIGS. 12 and 13, both of which were drawn from the same plant; in FIG. 12, five crowded inflorescences are present; in FIG. 13, three.

In contrast to this example a relatively complex branch-system may now be considered. In one of those studied the original branch bore two underleaves and a female inflorescence, just as in the first example, and the subfloral innovation was tipped with a second female inflorescence after bearing a single leaf and underleaf; the first inflorescence, however, bore a second innovation in the form of a short male spike at the base of its outer bract, and the second female inflorescence bore a female branch in the same position, thus lying in a fork between its two innovations. The first of these innovations (that arising at the base of the outer bract) bore two underleaves (with their corresponding leaves) and then a perianth with its bracts, innovating on its inner side; the innovation thus formed bore an underleaf, a leaf with a short male spike at its base and then another unfertilized female flower with two subfloral innovations—one a short male spike and the other a female branch, bearing a third female inflorescence after forming three underleaves with the corresponding leaves. Beyond this third female inflorescence, which remained unfertilized a fourth and fifth, both unfertilized and borne on very short innovations, were developed, the branch-system being brought to a conclusion by a sterile and rudimentary innovation, just as in the case of the first branch-system described. The second innovation of the second female inflorescence was similar to the first bearing in all four female inflorescences and a single male spike, the latter arising as a subfloral innovation. This example, which bore thirteen female inflorescences in all, will give some idea of the complexities encountered, although an even more intricate condition might have been selected for description.

The perianth of *T. densiflora* (FIGS. 12 and 13) exhibits a considerable range of variability, this sometimes manifesting

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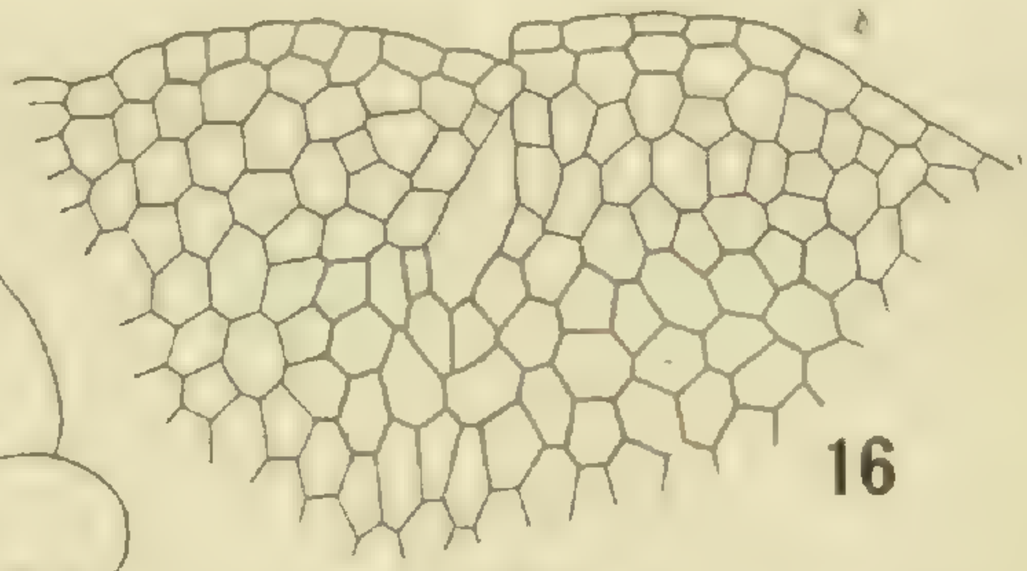

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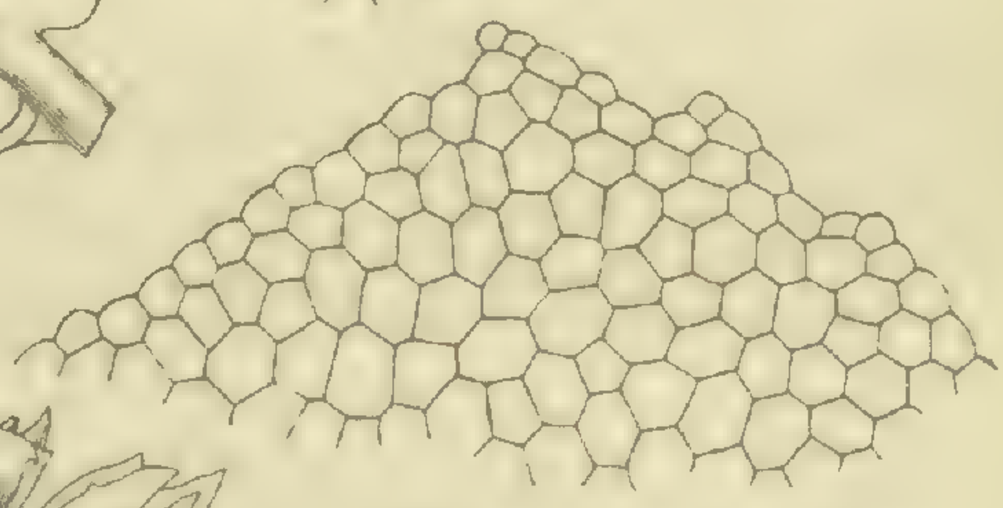

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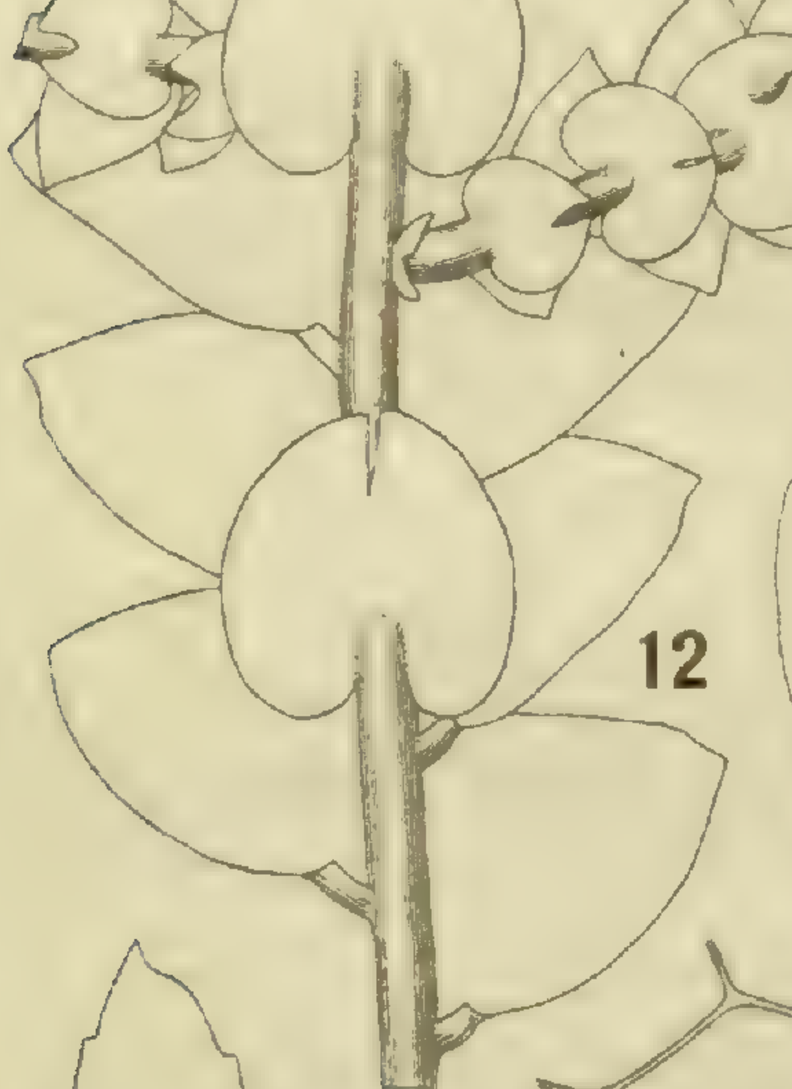

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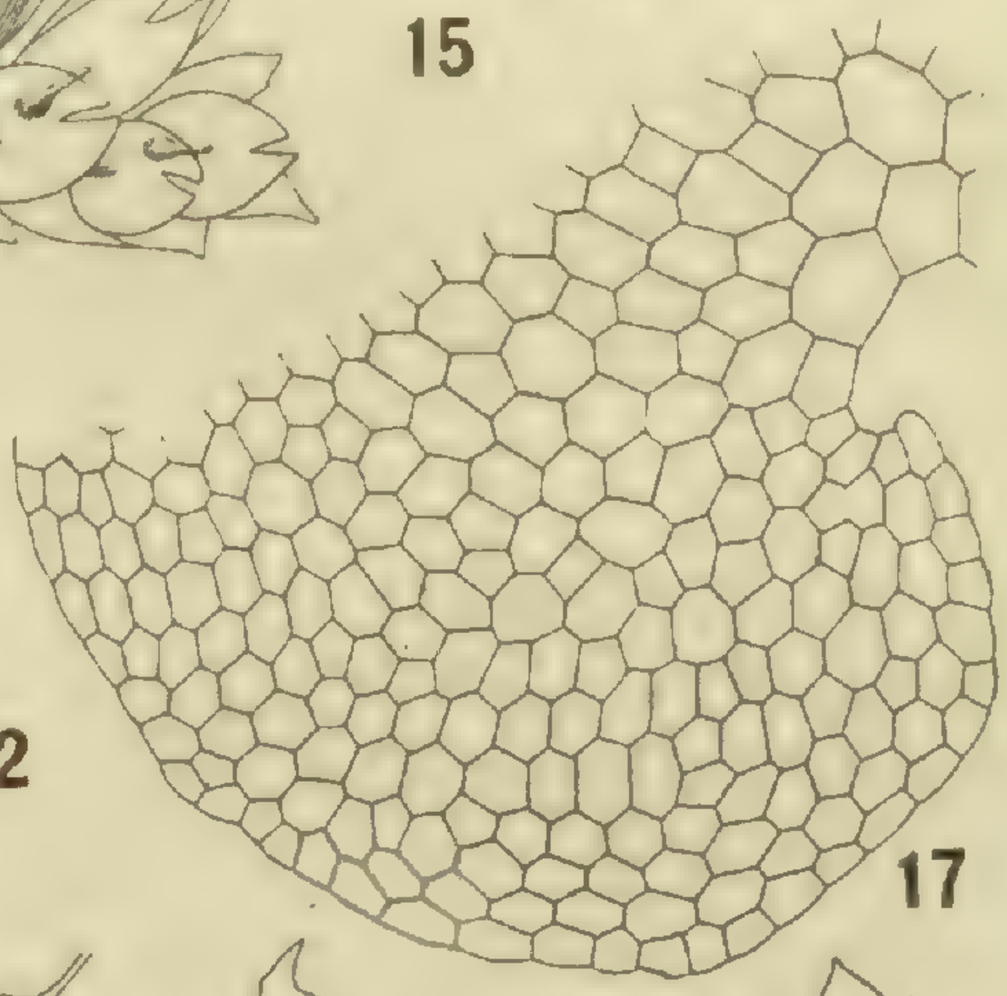

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TAXILEJEUNEA DENSIFLORA Evans

12. Part of a stem showing a female branch-system, ventral view, × 15. 13. Another female branch-system from the same stem, ventral view, × 25. 14. Cells from middle of lobe, × 265. 15. Apex of lobe, × 90. 16. Apex of underleaf, × 90. 17. Basal auricle of underleaf, × 90. 18–20. Bracts and bracteole from a single inflorescence, × 35. 21, 22. Bract and bracteole from another inflorescence, × 35. The figures were all drawn from the type specimen.

itself on a single plant or even on a single inflorescence branch-system. It broadens out in all cases from a narrow base and,

as it becomes old, is sometimes (as in so many other Lejeuneae) raised on a stalk representing an elongation of that portion of the female branch situated between the involucre and the perianth. In the lower part the perianth is terete but in the upper part five more or less distinct keels are present, the dorsal keel being sometimes less developed than the others. These keels may be nothing more than angular or rounded projections, but in most cases one or more of them will show a more or less distinct wing. These wings, in turn, may consist of nothing more than one or two projecting and rounded cells, but in their best development, although still remaining short and narrow they sometimes show from one to three sharp teeth, one or two cells long. Between these two extremes are many transitional conditions. In the upper part the perianth is truncate but the angles are either sharp or blunt according to the nature of the keels; sometimes a perianth will be sharp on one side and rounded on the other. The keel is slender and rather long, being composed (when well developed) of four superimposed circles of cells. When the perianths become old and especially after the capsules have been extruded, the upper part becomes stretched out and lacerated, although it never assumes the strikingly companulate form found in *T. sulphurea* and its allies.

A comparison of FIGS. 12 and 13 with FIG. 1 and also with PLATE 1, FIGS. 1 and 2, will show how strikingly the vegetative organs of *T. densiflora* resemble those of *T. pterogonia* and *T. jamaicensis*. The leaves, to be sure, spread at a somewhat greater angle and the auricles of the lobes (not shown in the figures) and of the underleaves tend to be less pronounced than in *T. pterogonia*, agreeing better with *T. jamaicensis*, but FIG. 17 shows that sometimes at least the auricles of the underleaves are well developed. There is moreover a tendency for the leaves and the divisions of the underleaves to be blunter, and a prolonged search is sometimes necessary before a leaf tipped with two superimposed cells can be demonstrated. The dentations on the leaves, when present, show a similar tendency to be blunt rather than sharp. The sinus of the underleaves is similar in all three species and of about the same length. In *T. densiflora*, however, rounded sinuses are somewhat more frequent and the

sides of the sinus are usually bounded by only six or seven cells instead of by eight to ten as in *T. pterogonia* and *T. jamaicensis*. It will be seen at once that all these differences are vague and unsatisfactory, being found in very variable organs.

A more important distinction is found in the greater size of *T. densiflora*. This is indicated by comparing FIG. 1 with FIG. 12, the latter of which is magnified about 40 per cent more. The leaf-cells are also considerably larger (compare FIG. 14 with PLATE —, FIG. 4) and are further distinguished by their very poorly developed thickenings. The trigones in fact are often absent altogether and, even when present, are minute and have concave sides, so that they can be discerned only with difficulty. Intermediate thickenings are absent altogether or very vaguely indicated, and there seems to be no trace of the minute verruculae found in the other two species. Perhaps the poorly developed thickenings are associated with the wet conditions under which the species develops.

The bracts and bracteoles (FIGS. 18–22), except for their larger size and laxer structure, have little to distinguish them from those of *T. jamaicensis*, and it has already been shown how vague the distinctions are between this latter species and *T. pterogonia*. In *T. densiflora* it is rare to find a bract which is wholly without teeth, although these may be very vague, and the lobule is rarely anything more than a basal fold, with or without a distinct apex. The teeth on the sides of the bracteole are somewhat less in evidence than in either of the other two species.

4. TAXILEJEUNEA DEBILIS (Lehm. & Lindenb.) Steph.

Jungermannia debilis Lehm. & Lindenb. in Lehmann, Pug. Plant. **4**: 51. 1832.

Lejeunea debilis Nees & Mont. Ann. Sci. Nat. Bot. II. **5**: 60. 1836.

Omphalanthus debilis Lehm. & Lindenb. in G. L. & N. Syn. Hep. 306. 1845.

Omphalanthus martinicensis Gottsche, Ann. Sci. Nat. Bot. V. **1**: 149. 1864 (in obs.).

Lejeunea (*Taxilejeunea*) *debilis* Steph. Hedwigia **29**: 141. 1896.

Taxilejeunea martinicensis Steph. Hedwigia **35**: 135. 1896.
Taxilejeunea debilis Steph. Sp. Hepat. **5**: 451. 1913.

Pale yellowish or whitish green growing in loose mats, often pure but sometimes in admixture with other bryophytes: stems mostly 0.15–0.2 mm. in diameter, irregularly and usually sparingly branched, the branches obliquely spreading usually with smaller leaves than the stem: leaves loosely imbricated, the lobe obliquely spreading, plane to strongly convex, scarcely falcate, ovate, mostly 1–1.2 mm. long and 0.9–1 mm. wide, dorsal margin arching across the stem and distinctly auriculate at the base, margins and apex of lobe, features of lobule and leaf-cells much as in *T. jamaicensis;* underleaves contiguous to loosely imbricated, convex (from below) and often involute, orbicular, mostly 0.06–1 mm. long, the basal auricles and margin much as in *T. jamaicensis* but the apical sinus often bluntly pointed to lunulate instead of being narrow and acute and the segments usually sharper and sometimes tipped with two cells: inflorescence dioicous: ♀ inflorescence sometimes borne on a short branch sometimes on a more elongated branch, innovating on one side, the innovation usually only once floriferous; bracts somewhat spreading, keel rounded, lobe straight not falcate, ovate to oblong, mostly 0.65–0.9 mm. long and 0.3–0.45 mm. wide, acute, often irregularly toothed, the teeth mostly sharp and sometimes consisting of single projecting cells, usually only three or four, lobule sometimes distinct but often scarcely evident, mostly 0.15–0.2 mm. long and 0.05–0.07 mm. wide; bracteole free or nearly so from the bracts, obovate to oblong, mostly 0.7–0.9 mm. long and 0.45–0.65 mm. wide, bifid about one third with a narrow sinus and erect acute divisions, margin crenulate and sometimes bearing a sharp tooth on one or both sides; perianth more or less exserted, obovoid, mostly 0.75–0.85 mm. long and 0.45 mm. wide, cuneate toward the base and truncate at the apex with a short beak, five-keeled in the upper part, the keels crenulate from projecting cells but without wings or teeth: ♂ inflorescence as in *T. pterogonia.*

On banks and rocks, more rarely on logs; widely distributed in tropical America. The specimens listed have all been personally examined by the writer; several of the determinations have unfortunately been made from sterile material, but this has usually been abundant and in good condition. A few other records for the species will be noted later.

MEXICO: without definite locality, *F. Liebmann* (Underwood Herbarium, from Sullivant Herbarium); Orizaba, 1887, *C. Mohr*

(Underwood Herbarium); Zacuapan, Vera Cruz, 1908, *C. A. Purpus 5540, 5541*.

GUATEMALA: near the Finca Sepacuité, Alta Verapaz, 1902, *Cook & Griggs 75, 443;* trail between Sepacuité and Pangos, Alta Verapaz, 1905, *Maxon & Hay 3112;* trail between Sepacuité and Secanguin, Alta Verapaz, 1905, *Maxon & Hay 3117;* Cubelquitz, Alta Verapaz, 1906, *H. von Türckheim 5104* (Bryotheca E. Levier).

NICARAGUA: Volcan Mombacho, Department of Granada, 1903, *C. F. Baker 2505* in part (Plants of Pacific Central America).

COSTA RICA: La Esmeralda, Massif da Barba, 1892, *P. Biolley* 15628 (herbarium of the New York Botanical Garden).

JAMAICA: Beaufort Hill, Westmoreland Hills, New Market, 1907, *Britton & Harris 598;* Dolphin Hill and vicinity, 1908, *N. L. Britton 2335*.

MONTSERRAT: Pond Mountain, 1907, *J. A. Shafer 870*.

GUADELOUPE: without definite locality or date, *L'Herminier;* Grand-Marron, 1902, *Père Duss 1026* (distributed as *T. caripensis* Gottsche).

MARTINQUE: various localities, 1897–1900, *Père Duss 8, 19, 118, 133, 179, 210, 593, 616* (herbarium of the New York Botanical Garden); between St. Pierre and Champflore, 1868 *T. Husnot* (Pl. des Antilles *243*, as *Omphalanthus martinicensis* Gottsche).

ST. VINCENT: without definite locality or date, *L. Guilding* (Mitten Herbarium).

TRINIDAD: Mt. Tocuche, 1920, *Britton, Coker & Rowland 1486, 1494* in part, 1498; Maracas Waterfall, 1920, *Britton, Hazen & Coker 1678*.

PERU: San Miguel, 1911, *H. W. Foote* (listed by the writer in Trans. Connecticut Acad. 18: 315. 1914).

In their description of *Jungermannia debilis* the original authors, Lehmann and Lindenberg, state that the leaves are semivertical, obliquely cordate, acuminate, entire or bidentate at the apex, decurrent at the base and shortly complicate, adding that the stems appear filiform on account of the inflexion of the leaves. They describe the underleaves as equalling the leaves in

size, cordate-oval in form, subpeltate (in allusion to the strongly arched line of attachment), and more deeply emarginate than the leaves, the sinus being narrow and the laciniae acute.

This original description was drawn from sterile material collected on the island of St. Vincent, the name of the collector not being mentioned. Although the type has not been examined by the writer, a specimen in the Mitten Herbarium, which apparently represents a co-type, has been carefully studied. This specimen was collected on St. Vincent by L. Guilding and came originally from the Hooker Herbarium. It agrees in all essential respects with the original description, except that the leaves are acute or apiculate rather than "acuminate," indicating that the latter term was not well chosen. It agrees also with the other specimens listed above, so far as this can be established in the absence of female branches and perianths.

Unfortunately most of the important differential characters of the species, as here delimited, are based on these very parts, and the vegetative characters of *T. debilis* are largely duplicated in *T. pterogonia*, *T. jamaicensis* and (to a less extent) *T. densiflora*. In other words all four species show auricles at the base of the leaves and underleaves; acute for apiculate leaf-lobes, crenulate throughout and often sparingly dentate in the apical portion; and a short apical sinus on the underleaves with more or less sharp-pointed divisions. Both *T. pterogonia* and *T. jamaicensis*, moreover, show a cell-structure which is essentially like that of *T. debilis*, the trigones, intermediate thickenings and superficial verruculae being much the same. Under the circumstances it might at first seem justifiable to give up the name *T. debilis* altogether, regarding the sterile type as indistinguishable from the allied species. When the underleaves are carefully compared, however, the apical sinus of *T. debilis* is seen to be frequently rounded or lunulate, whereas this condition is rarely found in *T. pterogonia*, *T. jamaicensis* or *T. densiflora*. On the basis of this vague and not too constant difference the validity of *T. debilis* may still be maintained and the determination of sterile material may be attempted.

In the speicimens here referred to *T. debilis* underleaves with rounded or lunulate sinuses are associated with five-keeled peri-

anths destitute of both wings and teeth.* As the citations show specimens of this type are widely distributed in the Lesser Antilles, whereas (according to our present knowledge) specimens with toothed or winged keels have not yet been found there. It is to be regretted that authors have associated the name *T. debilis* with specimens in which the keels of the perianth are toothed and often winged, thus giving rise to much confusion. As the history of the species will show their conception of its characters was drawn largely from continental material, rather than from material collected in the West Indies.

Four years after its original publication *Lejeunea debilis* was recorded from "Peru" by Nees von Esenbeck and Montagne, neither the definite locality nor the collector's name being mentioned. These authors, in their description, make no mention of floral organs, thus implying that their new material was likewise sterile, but they amend some of the phrases of the original description. They state, for example, that the leaves are narrowed at the apex but that they may be obtuse, acute or truncate-subbidentulate, and they state further that the divisions of the underleaves may sometimse be obtuse. Three years later Montagne† gave a fuller account of these same specimens, stating that that they were collected by A. d'Orbigny between Chupé and Yanacaché in the province of Yungas, in Bolivia, thus indicating that they did not come from Peru in the modern sense. Montagne described the female branches and floral organs from the Bolivian material (showing that it was really fertile) and figured various structural details. According to his account the inflorescences are borne on very short branches, one to three being present on a branch; the perianth is obovate-oblong or pyriform, five-angled at the dilated apex, the angles being compressed and dentate; the bracts are irregularly dentate, sometimes bifid at the truncate apex; and the bracteole is repand-dentate and more deeply bifid

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*A somewhat ambiguous statement by Lehmann and Lindenberg may here be mentioned. To their description of *J. pterogonia* they add a note in which they compare this species with their *J. debilis* and also with *J. isocalycina* Nees, to both of which they apparently assign a smooth perianth without keels. In all probability however, they meant this to apply to *J. isocalycina* alone, since they had distinctly stated in their description of *J. debilis* that the fruit was lacking.

† D'Orbigny, Voy. l'Amér. Mérid. 7²: 65. *pl. 1, f. 2.* 1839.

at the apex [than the underleaves], the divisions being "acuminulate" and connivent. The figures are not altogether successful and fail to show distinct basal auricles in either leaves or underleaves. Montagne himself criticises the figure showing a female branch-system, stating that the features of the perianths are not well brought out. The branch-system in the figure shows a rather long branch with five perianths, but it is impossible to learn from it the sequence in which the inflorescences arose. The figure of a single perianth, dissected open, shows distinct teeth in the upper part.

In the Mitten Herbarium there is a specimen of "*Omphalanthus debilis*" from "Peru" received from Montagne. In all probability this represents a part of D'Orbigny's Bolivian material, although no information to this effect is given on the label. The specimen shows short female branch-systems, usually with two inflorescences on each and five-keeled perianths with the keels distinctly toothed. They thus agree with Montagne's statements. In the writer's opinion, however, this specimen should be referred to *T. pterogonia* (where it is already listed), rather than to *T. debilis*, in spite of the fact that Montagne's determination has heretofore been accepted without question.

The authors of the Synopsis Hepaticarum, in 1845, incorporated Nees von Esenbeck and Montagne's corrections and additions in their description of *Omphalanthus debilis*, although they comment adversely on Montagne's figures. In the supplement to the Synopsis, published two years later (p. 746), they quote in full Montagne's description of the floral organs, but in their own description they improve his phrase relating to the keels of the perianth by describing them as cristate-dentate. They apparently gained their idea of the floral organs entirely from specimens collected on the mainland, since the only West Indian specimen cited is the sterile type from St. Vincent. The authors clearly accepted the species in a rather broad sense, since they distinguished and in most cases briefly characterized the following forms: α, *originalis* (St. Vincent, the original specimens); α^*, *Liebmanianus* (Mirador and Zacuapan, Mexico, *Liebmann 27, 539a*); α^{**} (Amatian, Mexico, *Liebmann 309*); β, *angustior* (Hacienda da Jovo, Mexico, *Liebmann 515*); γ, *Orbignianus* ("Peru," D'Orbigny

in Herb. Montagne); and γ*, *columbicus* (Merida and Tovar, Venezuela, *Moritz 83*). The suspicion is thereby aroused that their *O. debilis* may have been an aggregate.

Gottsche, in his Mexikanske Levermossor (p. 272), adds further details about *O. debilis*, and especially about the Mexican specimens. He states that these are somewhat smaller than the St. Vincent specimens and gives measurements of the leaves and underleaves in α* *Liebmanianus* (*539a*) and in α** (*309*), as follows: lobes, 0.8–1 x 0.75–0.85 mm.; lobules, 0.13 x 0.1 mm.; underleaves 0.8–1 x 0.75–1 mm. He calls attention also to the crenulate margins of the leaves and underleaves.

In Stephani's revision of the Lindenberg specimens he accepts as correctly determined most of those listed in the Synopsis, so far as these are represented. The only exception is the γ, *columbicus*, which he regards as a mixture of *T. debilis* and *T. pterogonia*, as already noted under the latter species.* He cites *T. debilis* further from Martinique† and also from Guadeloupe, thus ascribing to it a wide geographical distribution in both North and South America. In his Species Hepaticarum (p. 463), however, where he assigns a dioicous inflorescence to the species, he restricts its range to the "Insulae antillanae," but does not state what disposition he makes of the Mexican, Venezuelan and "Peruvian" specimens which he had formerly referred to *T. debilis*. Neither does he indicate in any way which specimens served as the basis for his description of the perianth and involucral leaves. On the whole his account of the perianth does not differ greatly from that of Montagne; he states that it is clavate, three times as long as wide, truncate at the apex and armed with very irregular laciniae, adding that the ventral keels are short, widely divergent and similarly armed, and that the beak is long and slender. His account of the bracts is more at variance; he describes the lobe as narrowly lanceolate, about half as long as the perianth, acute and entire; and the lobule as small, linear, obtuse and not discrete from the lobe.

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* His statements regarding γ, *columbicus*, have since been confirmed by Schiffner (Bot. Jahrb. **23**: 579. 1897).

† In the Synopsis a specimen from Martinique (in the Hampe Herbarium) is listed but, in the supplement, doubt is thrown on the corrections of the determination. Whether or not this is the specimen studied by Stephani does not appear.

Other allusion to *T. debilis* in the literature add very little to our knowledge of the species. Gottsche* mentions it briefly in connection with his *Omphalanthus laevis* and *O. leioscyphus* from Colombia, and Spruce,† in connection with his *Lejeunea* (*Taxi-Lejeunea*) *chimborazensis* from Ecuador. It is listed also, without comment, by Bescherelle‡ from Martinique, by Duss‖ from the same island, and by the writer from Peru.§ Several of the specimens recorded from the French Antilles have been verified. Although the species is known from so many of the Lesser Antilles it is not listed by Spruce¶ in his account of the Hepaticae collected by W. R. Elliott on the islands of Dominica and St. Vincent. It is rather remarkable that it has not been found on the latter island since the time of Guilding.

T. martinicensis, which is here included among the synonyms of *T. debilis*, was based on material collected by L'Herminier on the island of Martinique. When Stephani published it in 1896 he made no mention of Gottsche as author, but in his Species Hepaticarum (**5**: 472), seventeen years later, he cited "*Omphalanthus martinicensis* Gottsche ms." as a synonym. Strictly speaking this name is not wholly a manuscript name. It was published in 1864 by Gottsche (as already noted in the synonymy), in connection with his *Omphalanthus leioscyphus* from Colombia. Although he gave no formal description of his *O. martinicensis* he distinguished it from *O. debilis* (to which he considered it allied) by its smooth perianth and entire bracts, and also pointed out numerous differencés between *O. martinicensis* and *O. leioscyphus*. The name *O. martinicensis* appears also in Husnot's catalogue of the bryophytes collected in the French Antilles, where the specimens distributed in his "Plantes des Antilles" are enumerated.** These specimens were determined by Gottsche and the one issued under the name *O. martinicensis* presumably agrees with L'Herminier's type. Although Gottsche apparently knew his species from

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* Ann. Sci. Nat. Bot. V. **1**: 148. 1864.

† Trans. Bot. Soc. Edinburgh **15**: 216. 1884.

‡ Jour. de Bot. **7**: 179. 1893.

§ Enum. méth. Musc. Ant. Franç. I. Hépatiques 8. Lons-le-Saunier. 1903.

‖ Trans. Connecticut Acad. **18**: 315. 1914.

¶ Jour. Linn. Soc. Bot. **30**: 331–372. *pl. 20–30*. 1894.

** Rev. Bryol. **2**: 3. 1875.

Martinique only, Stephani (in his Species Hepaticarum) gives as its habitat, "India occidentalis," adding that it is very common.

Stephani's descriptions of *T. martinicensis* are full and clear. He assigns to the species a dioicous inflorescence; contiguous, obliquely spreading, ovate-oblong leaves, acute or apiculate at the apex and sparingly dentate in the apical portion (entire or obliquely truncate-bidentate according to his 1896 description); a small ovate lobule, equalling the diameter of the stem and acutely angled at the truncate apex; cells measuring 36 μ in the middle of the leaf and 36 x 54 μ in the basal portion, with scarcely evident trigones; underleaves surpassing the leaves in size, cordate at the base (the basal auricles rotund and not connivent), and narrowly incised at the apex with an obtuse sinus and "acuminate acute" divisions; lanceolate (or ovate-lanceolate), entire and acute bracts, half the length of the leaves and with a short, linear acute or obtuse lobule, not discrete from the lobe; an obovate-obconic bracteole, as long as the bracts but twice as wide, one third incised-bilobed with a "straight" sinus and triangular, acuminate acute divisions (connivent and sometimes sparingly toothed in the 1896 description); and a small obovate-oblong perianth (measuring 1 x 0.6 mm.), truncate and obsoletely beaked at the apex, five-angled in the upper part, the angles or keels being entire.

If Stephani's descriptions of *T. martinicensis* are compared with his account of *T. debilis* it will be seen that the only important differences brought out are those derived from the perianth. In the herbarium of the New York Botanical Garden there is a fine series of *T. debilis*, collected by Père Duss on Martinique and determined by Stephani. Some of these specimens are completely sterile or show male inflorescences only; others are female and in some cases show well-developed perianths. So far as the writer has been able to observe these organs are invariably five-angled and destitute of wings and teeth. It is clear therefore that Stephani did not hesitate to refer to *T. debilis* plants which showed the perianth-characters of *T. martinicensis*. The study of the specimens of *T. martinicensis*, distributed by Husnot, shows that obtuse leaves are of occasional occurrence; that the auricles of the underleaves are sometimes so well developed that they almost

touch; that similar auricles (not mentioned by Stephani) are present on the leaves; that the thickenings in the cell-walls are sometimes better developed than he implies; and that surface-verruculae can almost always be demonstrated. Unfortunately this specimen is destitute of female inflorescences, but the evidence of variation which it exhibits serves to break down still further the distinctions between *T. martinicensis* and *T. debilis*, and the writer has no hesitation in considering them synonymous.

Another species which is clearly in need of further study is *T. dissitifolia* Steph.,* based on a specimen collected by Père Duss on the island of Guadeloupe. This species is known to the writer from description only, and Duss states, in listing it, that his own specimen is lost. So far as the description goes there is nothing to distinguish *T. dissitifolia* from *T. debilis* as here described, and the writer is inclined to regard the two species as synonymous. In the absence of specimens, however, it is impossible to reach a definite conclusion.

The close relationship existing between *T. debilis* and the three other species treated in the present paper has already been emphasized. Perhaps the closest relative of all is *T. jamaicensis*, and it was with some hesitation that the writer decided to propose the latter species as new. Aside from the difference in the underleaves, however, *T. debilis* is distinguished from *T. jamaicensis* by its dioicous inflorescence and by the constant absence of wings and teeth on the keels of the perianth. The dioicous inflorescence is of course associated with frequent sterility. Many specimens have been collected in which no trace of sexual organs can be detected and even in female material perianths are often lacking. In the case of *T. jamaicensis* the presence of perianths can usually be demonstrated by careful examination.

SHEFFIELD SCIENTIFIC SCHOOL,
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* Symb. Antillanae **2**: 472. 1900. Not "Hedw., 1900, p. 472," as cited by Stephani in his Species Hepaticarum (**5**: 464. 1913).

Explanation of plate 2

TAXILEJEUNEA PTEROGONIA (Lehm. & Lindenb.) Schiffn.

1. Part of a stem showing two female branch-systems, ventral view, × 25. 2. Part of a stem showing a female branch-system and a male inflorescence, ventral view, × 25. 3. Leaf, dorsal view, × 25. 4. Cells from middle of lobe, × 265. 5. Apex of lobe, × 90. 6. Apex of lobule, × 265. 7. Apex of underleaf, × 90. 8. Basal auricle of underleaf, × 90. 9. Bracts and bracteole from a fertilized inflorescence, the bracteole at the right, × 45. 10–12. Bracts and bracteole from another fertilized inflorescence (the second) of the same branch-system, × 45. 13. Bracts and bracteole from a fertilized inflorescence of another branch-system, × 45. 14, 15. Bract and bracteole from an unfertilized inflorescence of the same branch-system, × 45. 16–18. Bracts andbra cteole from another inflorescence, × 45. 19. Perianth, × 45. FIGS. 1, 3–15, and 19 were drawn from specimens collected at San Miguel, Peru, by Cook & Gilbert (*1180*); FIGS. 2 and 16–18, from specimens collected in the vicinity of Moody's Gap by E. G. Britton (*916*).

INDEX TO AMERICAN BOTANICAL LITERATURE

1917–1920

The aim of this Index is to include all current botanical literature written by Americans, published in America, or based upon American material; the word America being used in the broadest sense.

Reviews, and papers that relate exclusively to forestry, agriculture, horticulture, manufactured products of vegetable origin, or laboratory methods are not included, and no attempt is made to index the literature of bacteriology. An occasional exception is made in favor of some paper appearing in an American periodical which is devoted wholly to botany. Reprints are not mentioned unless they differ from the original in some important particular. If users of the Index will call the attention of the editor to errors or omissions, their kindness will be appreciated.

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Johns, C. O., & Gersdorff, C. E. F. The globulin of the cohune nut, *Attalea Cohune*. Jour. Biol. Chem. **45**: 57–67. *pl. 1.* D 1920.

Knudson, L. The secretion of invertase by plant roots. Am. Jour. Bot. **7**: 371–379 *f. 1.* 7 D 1920.

Kränzlin, F. Beiträge zur Kenntnis der Gattung *Telipogon* H. B. K. Ann. Naturh. Hofmus. Wien **33**: 9–38. 1919.
Includes 9 new species from tropical America.

Lee, H. A., & Serrano, F. B. Banana wilt in the Philippines. Phytopathology **10**: 504, 505. 1920.

Lloyd, F. E. Colloidal phenomena in the protoplasm of pollen tubes. Carnegie Inst. Washington Year Book **16**: 63, 64. 1917.

Lobo, B. Ilha da Trindade. Arch. Mus. Nac. Rio Janeiro. **22**: 107–158. 1919. [Illust.]
Includes a brief discussion of the flora.

Long, E. R. Dessication and respiration in succulent plants. Carnegie Inst. Washington Year Book **16**: 80–82. 1917.

Lowe, C. W. The flora of Warrens Landing, Lake Winnipeg, Manitoba. Can. Field Nat. **33**: 26–30. *f. 1, 2.* F 1920.

Lutman, B. F. Tip burn of the potato and other plants. Vermont Agr. Exp. Sta. Bull. **214**: 4–28. *pl. 1, 2* + *f. 1–9.* Je 1919.

Mabbott, D. C. Food habits of seven species of American shoal-water ducks. U. S. Dept. Agr. Bull. 862: 1–67. 30 D 1920.
Contains accounts of plants eaten by ducks.

MacDougal, D. T. The construction of a biocolloid exhibiting some of the water-relations of living plants. Carnegie Inst. Washington Year Book. **16**: 59, 60. 1917.

MacDougal, D. T. Growth of wheat (*Triticum*) and Corn (*Zea*). Carnegie Inst. Washington Year Book **16**: 85–87. 1917.

MacDougal, D. T. Imbibition in biocolloids as affected by acidosis, alkalosis, and neutralization. Carnegie Inst. Washington Year Book **16**: 60–62. 1917.

MacDougal, D. T. The physical basis of parasitism. Carnegie Inst. Washington Year Book **16**: 71–73. 1917.

MacDougal, D. T. Rate and course of growth of succulents. Carnegie Inst. Washington Year Book **16**: 83–85. 1917.

Mackenzie, K. K. Scientific names applicable to our purple-flowered Eupatoriums. Rhodora **22**: 157–165. 7 D 1920.

Mackie, W. W., & Briggs, F. N. Fungicidal dusts for control of smut. Science II. **52**: 540, 541. 3 D 1920.

Magalhaes, B. de. Antonio Luiz Patricio da Silva Manso. Arch. Mus. Nac. Rio Janeiro **22**: 79–96. 1919.

Marie-Victorin, Fr. Le "*Micrampelis lobata*." Nat. Canad. **46**: 172–174. F 1920.

Marie-Victorin, Fr. La vie sexuelle chez les Hydrocharitacées. Nat. Canad. **45**: 130–133. Mr 1919.

Maxon, W. R. New selaginellas from the western United States. Smithson. Misc. Coll. **72**[5]: 1–10. *pl. 1–6*. 22 D 1920.
Includes 6 new species.

Mayhew, I. P. Winter flowers in Massachusetts. Am. Bot. **26**: 140, 141. N 1920.

McGee, J. M. Experiments upon the imbibitional swelling of marine algae. Carnegie Inst. Washington Year Book **16**: 64, 65. 1917.

McLarty, H. R. A suspected mosaic disease of sweet clover. Phytopathology **10**: 501–503. *f. 3*. 1920.

McMurran, S. M., & Demaree, J. B. Diseases of southern pecans. U. S. Dept. Agr. Farmers' Bull. 1129: 3–22. *f. 1–23*. S 1920.

Merrill, E. D. Notes on Philippine Euphorbiaceae. Philipp. Jour. Sci. **16**: 539–579. Je 1920.

Metcalf, Z. P. Some ecological aspects of the tidal zone of the North Carolina Coast. Ecology **1**: 193–197. Jl 1920.

Mignault, L.-D. Quelques notes sur une mauvaise herbe. Nat. Canad. **45**: 181–183. Je 1919.
Euphorbia Helioscopia L.

Mignault, L.-D. Une plante interessante. Nat. Canad. **45**: 101–103. Je 1919.
Vallisneria spiralis.

[Moore, G. T.] Hats from plants. Missouri Bot. Gard. Bull. **8**: 113–116. N 1920.

Mousley, H. *Botrychium obliqnum* Muhl. and var. *dissectum* (Spreng.) new to the province of Quebec. Can. Field Nat. **33**: 97. N 1919.

Mousley, H. Further notes on the orchids of Hatley, Stanstead County, Quebec, 1919. Can. Field Nat. **33**: 44–47. N 1920.

Murrill, W. A. The fungi of Blacksburg, Virginia. Mycologia **12**: 322–328. 27 D 1920.
Includes *Pluteus praerugosus* sp. nov.

Murrill, W. A. Plants as an inspiration in the art of early peoples. Gard. Mag. **32**: 246–248. Ja 1921.

Nelson, J. C. Under which code? Am. Bot. **26**: 129–135. N 1920.

Odell, W. S. A rare fungus new to Canada. Can. Field Nat. **34**: 10–13. *f. 1–6.* 1920.

Osterhout, G. E. Rocky Mountain botany and the Long Expedition of 1820. Bull. Torrey Club **47**: 555–562. 28 D 1920.

Palmer, E. J. The ligneous flora of the Staked Plains of Texas. Jour. Arnold Arbor. **2**: 90–105. 1920.

Pammel, L. H. Some economic phases of botany. Science II. **53**: 4–15. 7 Ja 1921.

Parish, S. B. The immigrant plants of Southern California. Bull. So. Calif. Acad. Sci. **19**: 3–30. 1920.
Includes *Zauschneria orbiculata* sp. nov.

Pearson, G. A. Factors controlling the distribution of forest types. Ecology **1**: 139–159. *f. 1–8;* 289–308. *f.* 9–11. 1920.

Pennell, F. W. Soil preferences of Scrophulariaceae. Torreya **20**: 10, 11. 1 Ap. 1920.

Reddick, D. A fourth *Phytophthora* disease of tomato. Phytopathology **10**: 528–534. D 1920.

Rhoads, A. S. Studies on the rate of growth and behavior of the blister rust on white pine in 1918. Phytopathology **10**: 513–527. D 1920.

Richards, H. M. Gas interchange in *Mesembryanthemum* and other succulents. Carnegie Inst. Washington Year Book **16**: 79, 80. 1917.

Rickett, H. W. A quantitative survey of the flora of Lake Mendota [Wisconsin]. Science II. **52**: 641, 642. 31 D 1920.

Rusby, H. H. Descriptions of three hundred new species of South American plants. Pp. 1–170. 20 D 1920. New York.

Contains also an index to previously published South American species by the same author.

[H. H. Rusby]. The Mulford biological exploration of the Amazon basin. Am. Jour. Pharm. **92**: 815–820. N 1920.

Sampaio, A. J. de. A secção de Botanica no primeiro seculo de existencia do Museu Nacional. Arch. Mus. Nac. Rio Janeiro **22**: 37–47. 1919.

Schneider, C. Notes on American willows. X. Jour. Arnold Arbor. **2**: 65–90. 1920.

Includes 1 new variety and 2 new combinations.

Seifriz, W. Viscosity values of protoplasm as determined by microdissection. Bot. Gaz. **70**: 360–386. 24 N 1920.

Setchell, W. A. Geographical distribution of the marine spermatophytes. Bull. Torrey Club **47**: 563–579. 28 D 1920.

Sherff, E. E. North American species of *Taraxacum*. Bot. Gaz. **70**: 329–359. *pl. 31–33*. 24 N 1920.

Shreve, E. B. The relation between water loss by evaporation and water gain by absorption in colloidal gels. Carnegie Inst. Washington Year Book **16**: 68–71. 1917.

Shreve, E. B. The transpiring power of plants. Carnegie Inst. Washington Year Book 16: 67, 68. 1917.

Sifton, H. B. Some characters of xylem tissue in cycads. Bot. Gaz. **70**: 425–434. *pl. 37, 38* + *f. 1*. 30 D 1920.

Silveira, A. A. da. Algumas especies novas da flora de Minas Geraes. Arch. Mus. Nac. Rio Janeiro **22**: 99–103. *pl. 1–3*. 1919.

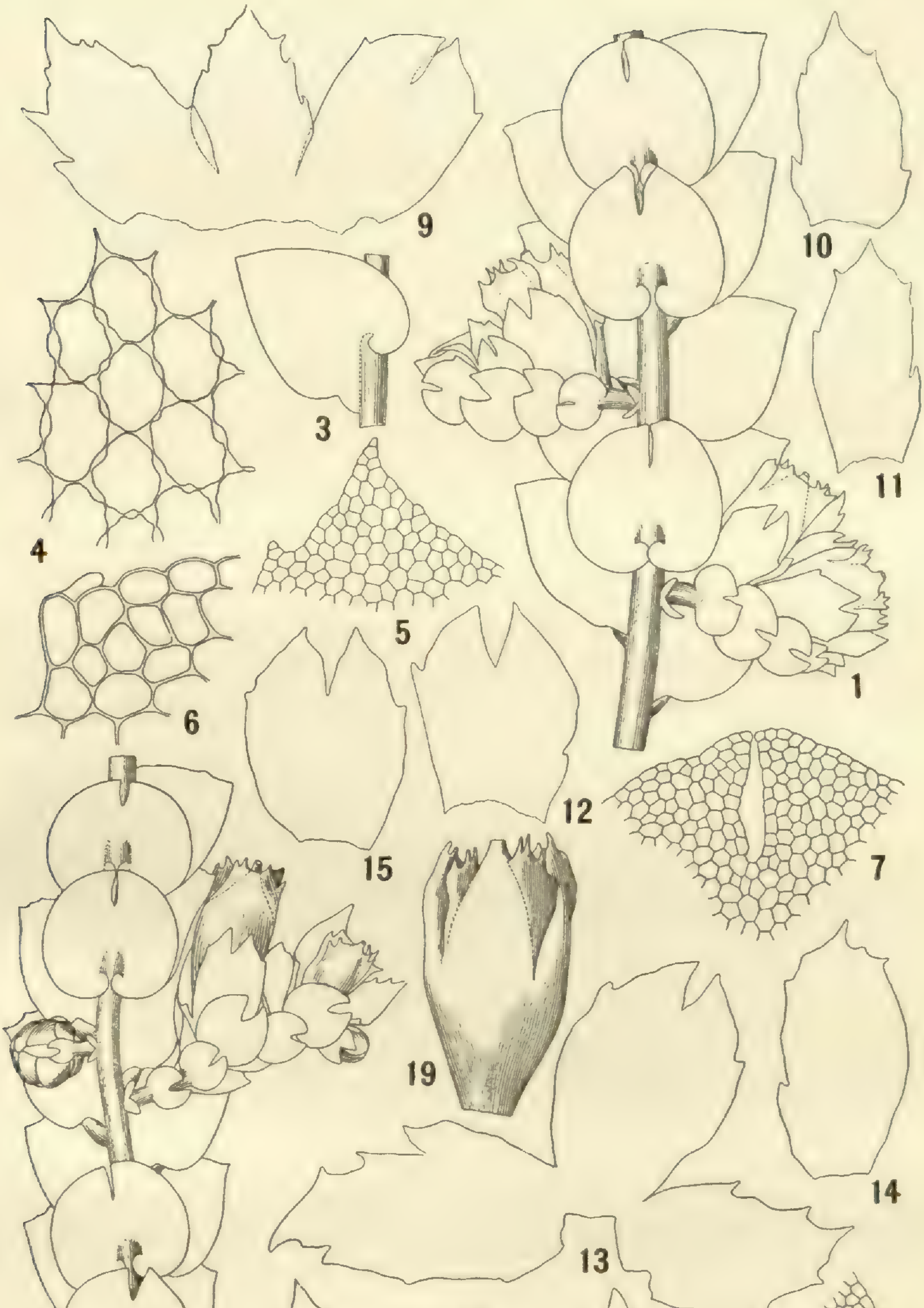
Includes new species in ***Chusquea***, ***Arundinaria*** and ***Bombax***.

Small, J. K. A botanical excursion to the Big Cypress. Nat. Hist. **20**: 488–500. O 1920. [Illust.]

Soth, B. H. The alpine spring beauty. Am. Bot. **26**: 115. N 1920.

Spoehr, H. A. The carbohydrate economy of cacti. Carnegie Inst. Washington Year Book **16**: 73–79. 1917.

Standley, P. C. A new species of *Campnosperma* from Panama. Jour. Arnold Arbor. **2**: 111, 112. 1920.



TAXILEJEUNEA PTEROGONIA (LEHM. & LINDENB.) SCHIFFN.

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BULLETIN

OF THE

TORREY BOTANICAL CLUB

MAY, 1921

Chondriomes in Chara

A. J. Riker

(WITH PLATE 3)

Chondriomes and mitachondria have received much attention in recent years. Foremost among the investigators along this line are Guilliermond, who has published a number of short papers, and Mottier (14). Both of these writers agree that chondriomes are distinct organs of the cells, and that they arise only from older chondriomes. These cell organs in *Chara* have been described as granulations that stain like nucleoli by Kaiser (11) and by Johow (10). Dębski (3, 4) found in the plasma of *Chara* bodies of a nucleolar structure, which probably arose from the nucleolus, and which showed strange enterings on the spindle fibers. Mirande (12), who has given this subject special attention recently, states that in the cells of *Chara* are found certain corpuscles that take the stains like nucleoli. He concludes that most of these corpuscles, which continue to multiply in the cytoplasm, are really nuclear in nature and are in part expelled by the nucleus itself. In the same paper he says that the chondriomes close to the nucleus migrate to the periphery of the cells, develop central vacuoles, and become chloroplasts. In due time he finds that they produce grains of starch.

For the investigation of the origin of these chondriomes in *Chara* and the rôle they play in the cells, material was collected near Covington, Kentucky, and identified according to Robinson

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(15) as *Chara fragilis*. A study was also made of *Chara verrucosa*, collected at Oberlin, Ohio.

METHODS

A number of killing agents were employed, including Carnoy's, Jeffrey's, Flemming's, Merkel's, Benda's, and dilutions of a 1 per cent chrom-acetic stock solution. The best results were obtained with Flemming's, Benda's and Merkel's solutions, all of which belong to the group recommended by Guilliermond (8) as causing the least change from the living condition. Care must be used while fixing the material because the chondriomes are rather easily destroyed by strong reagents. Flemming's weaker solution was tried at 0° C. and 50° C., but the best results were secured when the killing agent was of the same temperature as the water in which the *Chara* grew. Sections were cut at 5 μ and 7 μ, and stained with Haidenhain's iron-alum haematoxylin or Flemming's triple stain. Such stains as Giemsa's, Leishman's, and Wright's (Mallory and Wright) were also tried. These possess a certain value for this type of work because of the differential qualities and the rapidity of the staining, but they are likely to cause artefacts due to the precipitation of the stain. The lack of permanence of these stains is a further disadvantage.

Division figures are not easy to secure. Preliminary tests, in which growing tips were killed at intervals throughout the twenty-four hours, showed that mitotic division was most active at ten o'clock at night, and so for the final results the material was killed at this hour.

RESULTS

Since it is during the nuclear division that these chondriomes have their origin, it is necessary to study all the mitotic stages beginning with the resting cell.

While the cell is in the resting stage, the nucleolus shows refractive spots or granules. A similar appearance has been reported by Digby (5) and others in a variety of plants. As the spireme is formed, the nucleolus becomes irregular in shape, while it seems that streams of its contents flow out into the spiral thread (FIGS. 1 and 2). Mottier (13), while writing about nucleolar observations, says it is reasonable to suppose that the

nucleolar substance contributes materially to the growth of the chromosomes. On the same subject Andrews (1) says, "it is probably utilized as food in the growth of chromatic masses." Duggar (6) found an interesting connection between the chromatin content and the nucleolus, while Gardner (7) writes that the nucleolus is the important chromatic center, and that during division it becomes transformed into chromosomes. Wager (17) reports that during spireme formation the nucleolus becomes irregular in shape, undergoes ameboid changes of form, and then disappears just before the formation of the chromosomes. This describes exactly the changes that were observed in the present study of the growing tips.

In the metaphase and following stages the chromosomes remain entirely intact (FIG. 3). There is no sign of disintegration either of the central or outer portions. Hegner (9), working on the paedogenetic larvae of *Miastor*, finds that when the somatic cells become differentiated the middle portions of the chromosomes break up into granules which divide and go to the poles, while the swollen ends are cast into the cytoplasm. Boveri (2) has shown in *Ascaris* that when the cells specialize portions of the chromosomes separate off and disintegrate. But nothing of this kind occurs in *Chara*. Here the chromosomes migrate to the poles in the usual manner, with the mantle fibers extending from the center of the chromosomes. In the anaphase sixteen chromosomes move to each pole, corroborating the count of sixteen to eighteen made by Strasburger (16).

In the region of the median plate, after the chromosomes have been drawn away, a varying number (twelve to sixteen in *C. fragilis* and in *C. verrucosa* even more) of chromatic granules are found (FIG. 4), which are more or less globular in shape and which take the stains just as the chromosomes do. These granules, which are called prochondriomes hereafter, seem to lie between the spindle fibers and do not make connection with the mantle fibers. In size they vary from 0.6 μ to 1.4 μ in diameter, and the volume is calculated to be from 0.117 cu. μ to 1.47 cu. μ. As the chromosomes merge together in the telophase, these prochondriome granules may fuse so as to form eight or ten larger granules (FIG. 5), some of which may be up to 2.5 μ in diameter, or 4.9

cu. μ in estimated volume. The chromosomes are 0.7 μ in thickness and 5–6 μ in length, which gives a calculated volume of 2.37 cu. μ. It is estimated that the amount of chromatic material left behind in some cases may be equivalent to six or eight chromosomes, or almost half the amount of chromatin that makes up one of the daughter nuclei.

At the poles the chromosomes do not fuse directly into the daughter nucleus, but groups of them form pre-nuclear masses (Fig. 5), each of which contains a deeply stained chromatic spot resembling a nucleolus surrounded by a clear area. Then these pre-nuclear masses rapidly fuse into one large daughter nucleus (FIGS. 5–7).

The prochondriomes still persist on the median plate during the formation of the daughter nuclei. They do not disintegrate but soon migrate into the cytoplasm, where they divide repeatedly by fission to form bodies of different sizes. These are the granulations or chondriomes described by Mirande. Thus it appears that the greater number, at least, of the bodies staining as chondriomes in *Chara* may be nuclear in nature, and are, in part, expelled by the nucleus itself. On the other hand, this idea is exactly contrary to that of Guilliermond and Mottier, who say that chondriomes in general arise only from other chondriomes. Meves and Mottier suggest that, because chondriomes are such definite organs of the cell, they may be the bearers of certain hereditary qualities.

The leaves of *Chara* are formed by successive divisions of the tip cell. This tip cell seems to contain more of the chondriomes than any of the other cells. In fact the amount of chondriome material in the tip cells of the young leaves is approximately equal in many cases to the chondriome material in all cells below it. There is thus a progressive accumulation of chondriome material in the tip leaf cell during the successive divisions.

It is impossible actually to trace these prochondriomes to their position on the central plate, for they cannot be definitely picked out among the tangle of chromosomes in the metaphase. No more can their exact origin be seen. It would seem that they may be either (*a*) delayed chromosomes, (*b*) entire chromosomes which never go to the poles, (*c*) portions of chromosomes which

have been cut off, (*d*) unorganized portions of the spireme, or (*e*) chromatic material apart from and not included in the spireme. These possibilities are considered in order.

(*a*) If the original granules which first appear in the anaphase were delayed chromosomes, they would be considerably larger in size and greater in volume and would more nearly resemble the characteristic sausage shape of the chromosomes. Then, too, they would join the other chromosomes at the poles before the daughter nuclei were so nearly formed.

(*b*) Should they be chromosomes (in spite of their differences in size, shape and volume) which never go to the poles, there would be a progressive reduction in the number of chromosomes in the younger cells. Such, however, is not the case. Eight counts in different parts of the growing tip all gave sixteen as the constant chromosome number.

(*c*) They are not likely to be cut off portions of chromosomes, because in this event, the chromosomes in the cells which had undergone division a number of times would probably show a progressive diminution in size. According to Boveri (**2**) and Hegner (**9**) such diminution occurs in *Ascaris* and *Miastor*, where portions of the chromosomes are cut off at the time when somatic and germ cells are differentiated. In these cases the workers have shown that there is nuclear degeneration attendant on the specialization of the cells. However, nothing of this kind occurs in *Chara*. A careful comparison of the purely vegetative cells and those that might produce gametes, following the morphology according to Goebel, showed that there was no difference in the comparative size or number of the chromosomes or in the number of chondriomes produced.

(*d*) Unorganized portions of the spireme might form a few such prochondriomes. But there could not be so many unorganized portions as there are prochondriomes in the anaphase and still leave enough material for the full number of chromosomes which are formed.

ORIGIN OF THE PROCHONDRIOMES

(*e*) There is only one possibility of the origin of these prochondriomes which is not confronted with very serious objections. Since they probably are not chromosomes or portions of chromo-

somes, and do not seem to be unorganized portions of the spireme, they must be chromatin material not included in the spireme. The nucleolus is the most likely container of such material. In the resting stage the refractive spots or granules which may be seen in the nucleolus seem a probable source, because they resemble the prochondriomes in shape and staining reactions. It is possible that, if the nucleolus contains most of the chromatin which goes to make up the chromosomes, it could contain also the amount necessary to make the prochondriomes. Probably some of the granules of the resting nucleolus fail to pass into the spireme, when it is formed from some of the nucleolar material, and are then caught in the tangle of chromosome movement and carried on to the median plate. There they are left because of some difference between them and the granules of the chromosomes.

SUMMARY

1. Chromatic granules (prochondriomes) appear on the central plate in the anaphase of *Chara;* these do not disintegrate but migrate into the cytoplasm and become chondriomes.

2. These prochondriomes have their origin in the nucleolus.

3. Chondriomes are derived by fission from other chondriomes, but they are also produced as nuclear extrusions.

4. No difference in the prochondriome contents has been observed in the actively growing tip between the purely vegetative cells and those which may produce gametes.

5. The extrusion of these prochondriomes is apparently not connected with nuclear degeneration or differentiation of the germ and vegetative cells.

In conclusion the author wishes to acknowledge his obligation to Dr. Harris M. Benedict, of the University of Cincinnati, for his kind supervision during the investigation, to Professor F. O. Grover, of Oberlin College, for helpful suggestions, and also to other friends for the encouragement of their interest.

UNIVERSITY OF CINCINNATI

LITERATURE CITED

1. **Andrews, F. M.** Karyokinesis in *Magnolia* and *Liriodendron* with special reference to the behavior of the chromosomes. Beih. Bot. Centralbl. **11**: 132–142. *1 pl.* 1901.

2. **Boveri, T.** Die Entstehung des Gegensatzes zwischen den Geschlechtzellen und den somatischen Zellen bei *Ascaris megalocephala*. Sitzungsb. Ges. Morph. Physiol. München **8**: 114–126. *f. 1–6.* 1892.

3. **Dębski, B.** Beobachtungen über Kerntheilung bei *Chara fragilis*. Jahrb. Wiss. Bot. **30**: 227–248. *pl. 9, 10.* 1897.

4. ————————. Weitere Beobachtungen über *Chara fragilis*. *Ibid.* **32**: 635–670. *pl. 11, 12.* 1898.

5. **Digby, L.** The somatic, premeiotic and meiotic nuclear division of *Gallonia candicans*. Ann. Bot. **24**: 727–759. *pl. 59–63*. 1910.

6. **Duggar, B. M.** On the development of the pollen grain and embryo-sac in *Bignonia venusta*. Bull. Torrey Club **26**: 89–105. *pl. 352–354*. 1899.

7. **Gardner, B.** Studies on growth and cell division in the root of *Vicia Faba*. Contrib. Bot. Lab. Univ. Pennsylvania **2**: 150–182. *pl. 18 + f. 1–3*. 1904.

8. **Guilliermond, A.** Contribution a l'étude de la fixation du cytoplasme. Compt. Rend. Acad. Sci. Paris **164**: 643–645. 1917.

9. **Hegner, R. W.** The history of the germ cells in the paedogenetic larva of *Miastor*. Science II. **36**: 124–126. *f. 1.* 1912.

10. **Johow, F.** Die Zellkerne von *Chara foetida*. Bot. Zeit. **39**: 729–743, 745–753. *pl. 7*. 1881.

11. **Kaiser, O.** Über Kerntheilungen der Characeen. *Ibid.* **54**: 61–79. *pl. 2*. 1896.

12. **Mirande, M.** Sur le chondriome, les chloroplasts, et les corpuscules nucléo-lavies du protoplasme des *Chara*. Compt. Rend. Acad. Sci. Paris **168**: 283–286. *pl. 1*. 1917.

13. **Mottier, D. M.** Nuclear and cell division in *Dictyota dichotoma*. Ann. Bot. **14**: 163–193. *pl. 11*. 1900.

14. ————————. Chondriosomes and the primordia of chloroplasts and leucoplasts. *Ibid.* **32**: 91–114. *pl. 1*. 1918.

15. **Robinson, C. B.** The Chareae of North America. Bull. New York Bot. Gard. **4**: 244–308. 1906.

16. **Strasburger, E.** Einiges über Characeen und Amitose. Wiesner-Festschr. 24–47. *pl. 1*. 1908.

17. **Wager, H.** The nucleolus and nuclear division in the root-apex of *Phaseolus*. Ann. Bot. **18**: 30–55. *pl. 5*. 1904.

Explanation of plate 3

The figures were drawn with a Bausch and Lomb 1.9 objective and ocular 10, tube length 160 mm., with a camera lucida. The slides, from which the figures were drawn, were stained with Flemming's triple stain. The magnification is about 1300 diameters.

FIGS. 1, 2. Prophase. The nucleolus contributes to the formation of the spireme

FIG. 3. Metaphase. The chromosomes are intact and show no sign of disintegration.

FIG. 4. Telophase. Chromatic granules (prochondriomes) are left on the median plate.

FIG. 5. Late telophase. The prochondriomes still persist during the organization of the chromosomes into prenuclear masses. (The total number of prochondriomes in the section is shown.)

FIGS. 6, 7. Late telophase. The prochondriomes migrate into the cytoplasm as the new wall is formed.

Notes on Viburnum and the assemblage Caprifoliaceae

W. L. McAtee

(WITH ONE TEXT FIGURE)

For some years the writer collected and studied the plants known as Caprifoliaceae, especially those of the genus *Viburnum*, with a view of revising at least the American forms of the latter. As realization of this project does not seem likely, a few matters of general interest arising during the investigation are here set forth.*

Stellate pubescence in Viburnum.—Although used in American botanical manuals the term stellate is not properly applied to the pubescence in our species of the genus *Viburnum*. True stellate pubescence, present in some exotic species, consists of trichomes having single points of attachment but which higher up are expanded or branched in a radiate manner. The pubescence of the United States species of *Viburnum* consists of simple hairs or of groups of such hairs, in the latter case each with its own attachment to the epidermis. The proper adjective to apply to these grouped hairs is fasciculate, a term which fits them exactly and which, if not employed in such instances, falls into unfortunate disuse. Since the fasciculation may involve any number from two to some twenty hairs, it is not a very good character to use in keys to the species. Still more unsatisfactory are descriptions of the vestiture in which the misleading modifier "stellate" is used for the denser tufts, as it implies a more fundamental difference than really exists between species which intergrade through every degree of fasciculation of the pubescence.

Relationship of Viburnum nudum and Viburnum cassinoides.—The characters of these forms intergrade extensively; the length of peduncle relative to that of cyme and the crenulations of the leaf margin, characters usually cited in keys, are fully connected by individual variations. The following with reference to the leaf

* The writer is obliged to Messrs. S. F. Blake and P. C. Standley for reading this paper and for making beneficial suggestions.

margins in these species may be of interest. In both, the leaf margin is more or less inrolled and the revolute character is most marked in *V. nudum*, which is described as having chiefly entire leaves. *Viburnum cassinoides* is described as generally crenulate-denticulate; however, the manuals note that each species occasionally has the leaf form of the other. If the revolute margin of the leaf of *V. nudum* be unrolled, crenulations are visible; thus, while the leaf really possesses the character supposed to be distinctive of *V. cassinoides*, the rolling in of the margin hides it and gives the leaf the appearance of entirety. The crenulations also are visible in many *V. nudum* leaves without unrolling them, that is, the margin is only folded back and the crenulations lie flat against the lower surface of the leaf. Both types can be found on a single plant as can also both long and short peduncles. The most reliable character for separating *V. nudum* and *V. cassinoides* is the shape of the pit of the fruit. The former has a simple, thin, lenticular pit, the latter an elongate, fusiform and sulcate one. Even these differences are more or less obscured by variations in certain specimens, but extreme southeastern *V. nudum* seems typical and so do northern specimens of *V. cassinoides*. Despite general inosculation of characters, therefore, the writer is inclined to rank these two forms as species, which hybridize more or less throughout the extensive common portion of their ranges.

Whorled leaves in Caprifoliaceae.—The possession of whorled leaves has a number of times been cited as one of a combination of characters distinguishing the Rubiaceae from the Caprifoliaceae. Seeing that this does not hold, the writer has noted, and in most cases collected, specimens showing verticillate leaves in various Caprifoliaceae. Such leaves are found most frequently on strong root-shoots, and according to the theory elaborated by Dr. R. T. Jackson,* indicate the ancestral condition. Species of *Viburnum* on which whorled leaves have been seen include: *V. Opulus*, *V. acerifolium* (whorled branches also), *V. dentatum*, *V. pubescens*, *V. Lentago*, and *V. Lantana*. *Sambucus canadensis* with verticillate leaves has been collected also, as well as the following species of *Lonicera: L. japonica*, *L. tatarica*, *L. fragrantissima*, *L. hispidula*, and *L. thibetica*. The last species as seen in the Arnold Arbore-

* Mem. Boston Soc. Nat. Hist. **5**: 89–153. *pl. 16–25.* April, 1899.

tum frequently, one might almost say usually, has the leaves in whorls (three's, sometimes four's). The structure of plants with opposite leaves readily lends itself to the production of verticils, and as instanced here, the two types of foliation are hardly distinct enough to be given much weight in the major phases of classification.

Stipules in the Caprifoliaceae.—The most persistent efforts to name characters that will distinguish the Caprifoliaceae from the Rubiaceae have been centered on stipules. It being untrue that the assemblage of plants known as Caprifoliaceae entirely lacks stipules, various niceties of language have been used to indicate a difference where practically none exists. "Usually exstipulate," lacking "true stipules," and stipules if present adnate to the petiole are some of the expressions used. The first statement is more or less true but, demanding qualification, fails as a satisfactory character for distinguishing families. With respect to the second it must be said that special students of stipules agree in attributing such organs to the Caprifoliaceae.* Relative to the third definition, I may say that I have before me (gathered Maywood, Virginia, today, July 4, 1920) a piece of *Sambucus canadensis* with well-developed stipules on the petioles of leaves just beneath inflorescence, one of which when its leaf was stripped off remained adnate to the stem. In a specimen of *Viburnum Opulus* collected in the grounds of the United States Department of Agriculture, May 25, 1920, the stipules† are connected by wings which form a stipular cup completely encircling the stem (see Fig. 1). In some Rubiaceae the interpetiolar stipules are reduced to a mere stipular line and stipular lines are present in various caprifoils, notably *Sambucus;* moreover, what essential difference is there between the shallow cups formed by the interpetiolar stipules in some Rubiaceae and the perfoliate leaves of *Triosteum* and *Lonicera?* The idea that true stipules can be distinguished

* See an excellent paper on The Nature and Origin of Stipules (with review of the literature), by A. A. Tyler, Ann. N. Y. Acad. Sci. **10**: 1–49. *pl. 1–3.* April, 1897.

† These stipules are unusually large, and bear glands on their stalks, thus suggesting that they are relics of a progenitor of the species having compound leaves. Similar stipules were collected on the same species in the Washington Monument Grounds, D. C., May 28, 1910, their likeness to leaves being greater, since they showed a tendency to lobing.

from the false by their pertaining to the stem rather than to the petiole appears to take little account of the fact that the petiole itself is a product of the stem and that in so plastic a kingdom as plants the appendages of the petiole and those of the stem from which it springs can not be otherwise than connected by every possible gradation. In the most typically stipulate plants, such as *Rosa* and *Trifolium*, the stipules are lobes at the base of the petioles, to which they adhere when the leaves are torn off. Even though they are true stipules they certainly are not adnate to the stem. All in all, it is certain that the stipules of Caprifoliaceae can

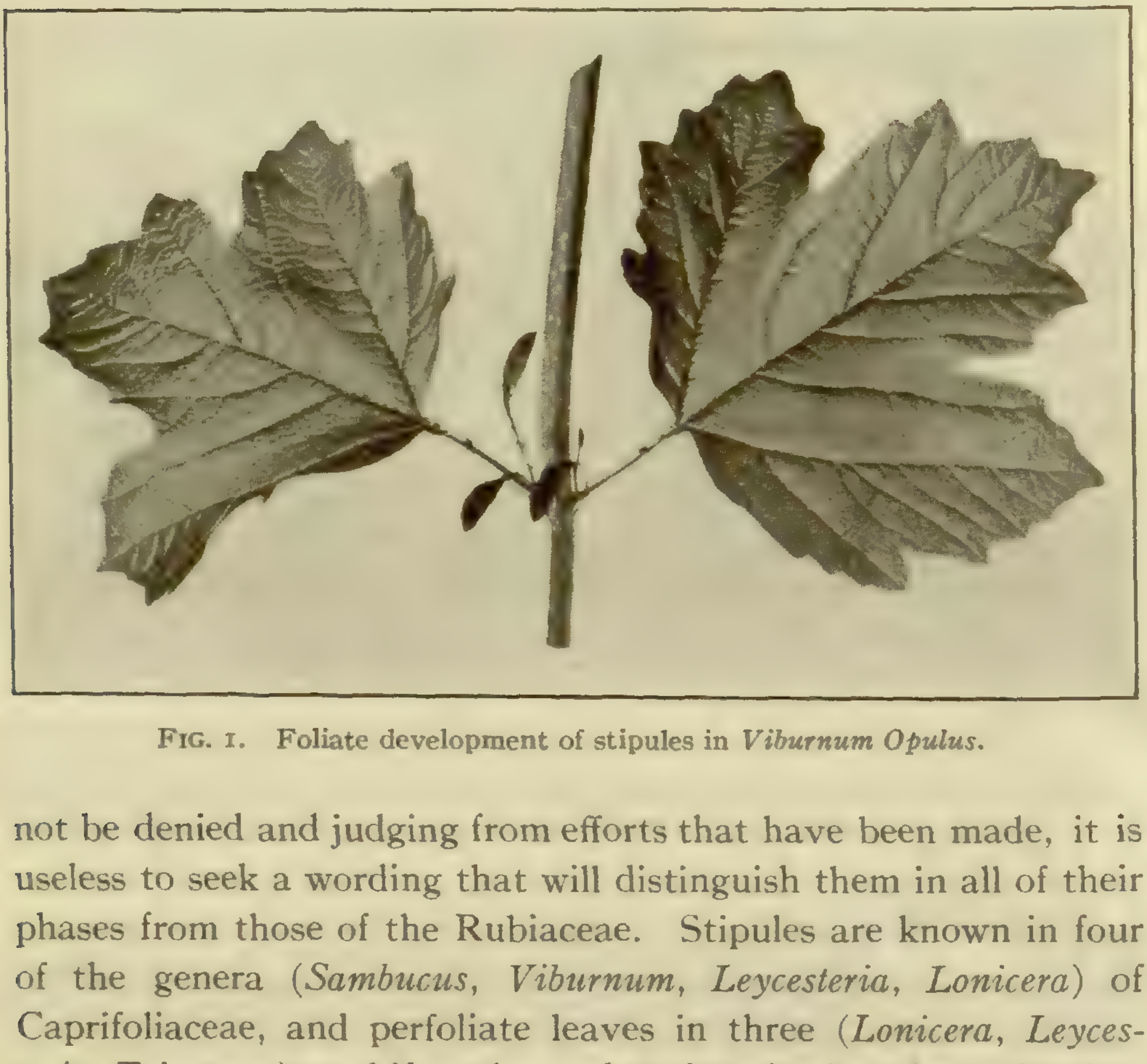

FIG. 1. Foliate development of stipules in *Viburnum Opulus*.

not be denied and judging from efforts that have been made, it is useless to seek a wording that will distinguish them in all of their phases from those of the Rubiaceae. Stipules are known in four of the genera (*Sambucus*, *Viburnum*, *Leycesteria*, *Lonicera*) of Caprifoliaceae, and perfoliate leaves in three (*Lonicera*, *Leycesteria*, *Triosteum*); and if we descend to the criterion of stipular line, as is done to evidence the genuineness of some Rubiaceae, we need exclude no caprifoils except those of the genus *Alseuosmia* which have alternate leaves.

Do the Caprifoliaceae merit family rank?—A rigorous yet entirely fair test of the validity of a classificatory group is: If

merged with its nearest relatives, will it remain a unit? Thus the Cichorieae, sometimes considered a family and sometimes ranged with the Compositae, do not in the latter process become scattered through the tribes of the Compositae but retain their integrity as a group. What happens to the Caprifoliaceae when this test is applied? It immediately becomes apparent that they have no character in common that will hold them together; they run to tribes in all parts of the Rubiaceae, some have one-seeded, others more than one-seeded carpels; some have dry fruits, others berries; some have the ovules suspended from the top of the ovaries, others from the septa. The variety of character with regard to verticillation of the leaves and the presence of stipules has been sufficiently set forth in preceding paragraphs. Some of the effects of this diversity upon their relation to the Rubiaceae are stated by Schumann, as follows: "The Diervillieae, for instance, have a surprising similarity in flower, fruit, and seed structure to the Cinchoneae; in the last analysis they are differentiated only by the lack of stipules in the former. Certain forms of Lonicereae, which are characterized by stipules (*Pentapyxis*), incline likewise to the tribe of Rubiaceae with numerous seeds, while some species of *Viburnum*, which are provided with stipules, harmonize with the Guettardeae."*

It would appear, therefore, that the Caprifoliaceae can not pass a test which should leave any satisfactory plant family intact, and with all due respect to those most erudite botanists, Bentham and Hooker, it would appear that their statement that the Caprifoliaceae are "a very natural order"† was made without sufficient consideration. Schumann appears to be more correct when he says "The Rubiaceae show the closest relationship to the Caprifoliaceae; various groups of them are so intimately related that one can raise no important objection to Baillon's view that the two families blend into one."

An even stronger statement is made by Fritsch relating to the group upon which he specialized: "The Caprifoliaceae are so closely allied to the Rubiaceae that it is impossible to give even one positive differential character for the two families."‡ It would

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* Engler & Prantl, Die natürlichen Pflanzenfamilien 4^{4-5}:13. 1897.

† Genera Plantarum 2: 1. 1873.

‡ Engler & Prantl, Die natürlichen Pflanzenfamilien 4^{4-5} : 160. 1897.

appear, therefore, that the Caprifoliaceae have been treated as a separate family from the Rubiaceae on chiefly hypothetical grounds. Artificiality is hardly called for in this case since the number of genera concerned, namely ten, is so small in proportion to the 350 of Rubiaceae that separating them does not significantly decrease the complexity of the larger group.

INDEX TO AMERICAN BOTANICAL LITERATURE

1917–1921

The aim of this Index is to include all current botanical literature written by Americans, published in America, or based upon American material; the word America being used in the broadest sense.

Reviews, and papers that relate exclusively to forestry, agriculture, horticulture, manufactured products of vegetable origin, or laboratory methods are not included, and no attempt is made to index the literature of bacteriology. An occasional exception is made in favor of some paper appearing in an American periodical which is devoted wholly to botany. Reprints are not mentioned unless they differ from the original in some important particular. If users of the Index will call the attention of the editor to errors or omissions, their kindness will be appreciated.

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Ames, O. Notes on Philippine orchids—VII. In Ames, Orchidaceae **6**: 273–310. *pl. 98–101.* 18 O 1920.

Ames, O. Orchidaceae. fasc. VI. pp. i–xiv + 1–335. *pl. 80–101.* Boston, 18 O 1920.

Includes papers on The orchids of Mount Kinabalu, British North Borneo and Notes on Philippine orchids VII, here indexed separately.

Ames, O., & Schweinfurth, C. The orchids of Mount Kinabalu, British North Borneo. In Ames, Orchidaceae **6**: 3–233. *pl. 80–97.* 18 O 1920.

Anderson, J. P. Supplemental list of plants from southeastern Alaska. Proc. Iowa Acad. Sci. **26**: 327–331. 1919.

Arthur, J. C. Aecidiaceae (cont.). N. Am. Fl. **7**: 337–404. 31 D 1920.

Arthur, J. C. New species of Uredineae—XII. Bull. Torrey Club **47**: 465–480. 29 O 1920.

18 new species and several new combinations.

Bailey, C. H., & Gurjar, A. M. Respiration of cereal plants and grains. Jour. Biol. Chem. **44**: 5–7. *f. 1;* 9–12. *f. 1;* 13–15; 17, 18. O 1920.

Bakke, A. L., & Plagge, H. H. Studies upon the absorption and germination of wheat treated with formaldehyde. Proc. Iowa Acad. Sci. **26**: 365–375. *f. 96, 97.* 1919.

Barnhart, J. H. The so-called generic names of Ehrhart's Phytophylacium. Rhodora **22**: 180–182. 14 Jan 1921.

Berry, E. W. Contributions to the Mesozoic flora of the Atlantic coastal plain, XIII. North Carolina. Bull. Torrey Club **47**: 397–406 *f. 1, 2.* 19 O 1920.

Includes 3 new species.

Brown, W. H. Wild food plants of the Philippines. Philipp. Bur. For. Bull. 21: 1–165. *f. 1–81.* 1920.

Burt, E. A. The Thelephoraceae of North America—XII. Ann. Missouri Bot. Gard. **7**: 81–248. *pl. 2–6* + *f. 1–48.* 8 D 1920.

Includes 10 new species in *Stereum*.

Clute, W. N. Plant names and their meanings. Am. Bot. **26**: 2–10; 57–61; 90–94; 116–124. 1920.

Conard, H. S., & Thomas, W. A. Measurements of wood fiber. Proc. Iowa Acad. Sci. **26**: 333–335. 1919.

Cook, M. T. Report of the department of plant pathology. New Jersey Agr. Exp. Sta. Ann. Rep. **40**: 523–535. *pl. 1–6.* 1920.

Contains list of plant diseases.

Cratty, R. I. The genus *Lactuca* in Iowa. Proc. Iowa Acad. Sci. **26**: 239–248. *f. 83.* 1919.

Cratty, R. I. *Ranunculus Purshii* in Iowa. Rhodora **22**: 183. 14 Ja 1921.

Curtis, O. F. The upward translocation of foods in woody plants. II. Is there normally an upward transfer of storage foods from the roots or trunk to the growing shoots? Am. Jour. Bot. **7**: 286–295. 6 Au 1920.

Davis, W. H. Mammoth clover rust. Proc. Iowa Acad. Sci. **26**: 249–258. *f. 84–90.* 1919.

Deam, C. C. Plants new to Indiana—VIII. Proc. Indiana Acad. Sci. **1918**: 144–150. 1919.

Detwiler, S. M. Safeguarding the white pine crop. Am. For. **27**: 7–11. Ja 1921.

Ensign, E. *Rosa pratincola* Greene. Proc. Iowa Acad. Sci. **26**: 303–310. 1919.

Fernald, M. L., & Wiegand, K. M. Studies of some boreal American cerastiums of the section *Orthodon*. Rhodora **22**: 169–179. 14 Ja 1921.

Includes *Cerastium terrae-novae* sp. nov.

Fitzpatrick, T. J. The fern flora of Nebraska. Proc. Iowa Acad. Sci. **26**: 311–326. 1919.

Gustafson, F. G. Comparative studies on respiration—XI. The effect of hydrogen ion concentration on the respiration of *Penicillium chrysogenum*. Jour. Gen. Physiol. **2**: 617–626. 20 Jl 1920.

Gustafson, F. G. Comparative studies on respiration—XII. A comparison of the production of carbon dioxide by *Penicillium* and by a solution of dextrose and hydrogen peroxide. Jour. Gen. Physiol. **3**: 35–39. *f. 152.* 20 S 1920.

Haupt, A. W. Gametophyte and sex organs of *Reboulia hemisphaerica*. Bot. Gaz. **71**: 61–74. *f. 1–21.* 20 Ja 1921.

Hervey, E. W. A rare variety of *Vitis labrusca*. Rhodora **22**: 183, 184. 14 Ja 1921.

House, H. D. Wild flowers of New York. New York State Museum Mem. **15**: 9–362. *pl. 1–264 + f. 1–35.* 1919.
Printed in 2 parts.

Hoyt, W. D. Marine algae of Beaufort, N[orth] C[arolina], and adjacent regions. Bull. U. S. Bur. Fish. **36**: 368–556 + iv. *pl. 84–118 + f. 1–47.* 30 D 1920.
Includes new species in *Streblonema* (1) and *Nitophyllum*. (1).

Jeffrey, E. C., & Torrey, R. E. Physiological and morphological correlations in herbaceous angiosperms. Bot. Gaz. **71**: 1–31. *pl. 1–7 + f. 1–4.* 20 Ja 1921.

Kelley, W. P., & Cummins, A. B. Composition of normal and mottled citrus leaves. Jour. Agric. Research **20**: 161–191. 1 N 1920.

Kränzlin, F. Orchidaceae quaedam Americanae. Vidensk. Meddel. Dansk. Naturh. Forening **71**: 169–180.
Includes new American species in *Pleurothallis* (2), *Restrepia* (1), *Sobralia* (1) *Macradenia* (1), *Warmingia* (1), *Habenaria* (2).

Kudo, R. Studies on Myxosporidia. Illinois Biol. Monog. **5**, No. 3. 4: 1–265. *pl. 1–25 + f. 1, 2.* 31 D 1920.
A synopsis of genera and species of Myxosporidia.

Ladbrook, J. A new species of *Coupoui*. Jour. Bot. **58**: 176, 177. Jl 1920.
Coupoui micrantha from Guiana.

Lamb, G. N. American grown cork. Am. For. **27**: 15, 16. Ja 1921.

Leachman, J. C. Indian uses of kelp. Sci. Am. Mo. **3**: 137–140. F 1921.

Lillie, R. S. The place of life in nature. Sci. Am. Mo. **3**: 112–117. F 1921.

Lloyd, C. G. Mycological notes **64**: 985–1029. *f. 1748–1859 + 3 portraits.* S 1920.
Includes translation of article by C. Torrend: The Polyporaceae of Brazil.

Loeb, J. Quantitative laws in regeneration. Jour. Gen. Physiol. **2**: 297–307. *f. 1–4;* 651–657. *f. 1–3.* 20 Jl 1920.
Studied *Bryophyllum calycinum* Salisb.

Mazza, A. Saggio di algologia oceanica. Nuova Notarisia **28**: 70–110; 176–239. 1917; **29**: 1–34; 57–112. 1918.

Mazza, A. Aggiunte al saggio di algologia oceanica. Nuova Notarisia **30**: 1–62. 1919; **31**: 1–64; 93–160. 1920.

Munns, E. R. High temperatures and eucalypts. Jour. For. **19**: 25–33. Ja 1921.

Nash, G. V. Hardy woody plants in the New York Botanical Garden. Jour. N. Y. Bot. Gard. **21**: 74–77; 119–124. 1920.

Noriega, J. M. Las plantas Mexicanas (*cont.*). Bol. Dir. Estud. Biol. **2**: 122–151. *f. 18–31.* Ja 1917.

Ostenfeld, C. H. A list of arctic Caryophyllaceae. Meddel. Grönland **37**: 223–227. 1920.
Includes several new combinations.

Pack, D. A. After-ripening and germination of *Juniperus* seeds. Bot. Gaz. **71**: 32–60. *f. 1.* 20 Ja 1921.

Pammel, L. H. The barberry in Iowa and adjacent states. Proc. Iowa Acad. Sci. **26**: 193–237. *f. 52–82.* 1919.

Pammel, L. H. The relation of native grasses to *Puccinia graminis* in the region of Iowa, western Illinois, Wisconsin, southern Minnesota, and eastern South Dakota. Proc. Iowa Acad. Sci. **26**: 163–192. *f. 41–51.* 1919.

Peck, M. E. Study of a section of Oregon coast flora. Proc. Iowa Acad. Sci. **26**: 337–362. 1919.

Reinking, O. A. Higher Basidiomycetes from the Philippines and their hosts—III. Philipp. Jour. Sci. **16**: 527–537. My 1920.

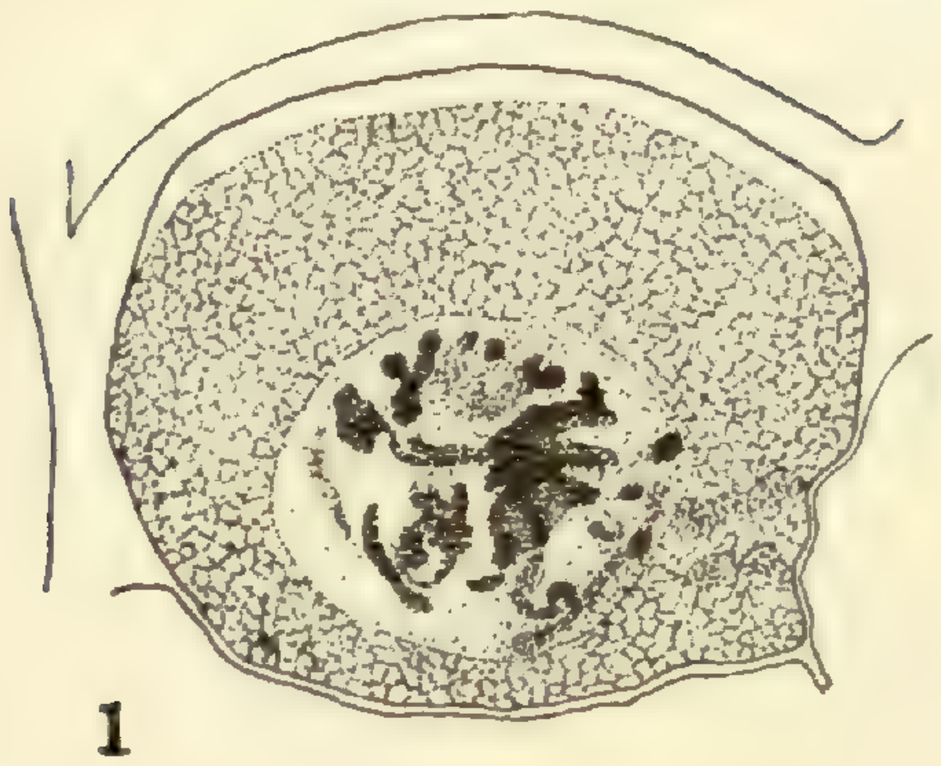
[**H. H. Rusby**]. New botanical drugs sought. Pharm. Era **53**: 321–324. N 1920.

Rydberg, P. A. Notes on Rosaceae—XII. Roses of northeastern North America. Bull. Torrey Club **47**: 45–66. 10 Mr 1920.

Rydberg, P. A. Phytogeographical notes on the Rocky Mountain region—IX. Wooded formations of the Montane Zone of the Southern Rockies. Bull. Torrey Club **47**: 441–454. 29 O 1920.

Sawyer, M. L. Hybridization in *Iris.* Proc. Iowa Acad. Sci. **26**: 363, 364. 1919.

Schufeldt, R. W. Tramps through the Southern States—II. Am. For. **26**: 540–547. S 1920. [Illust.]



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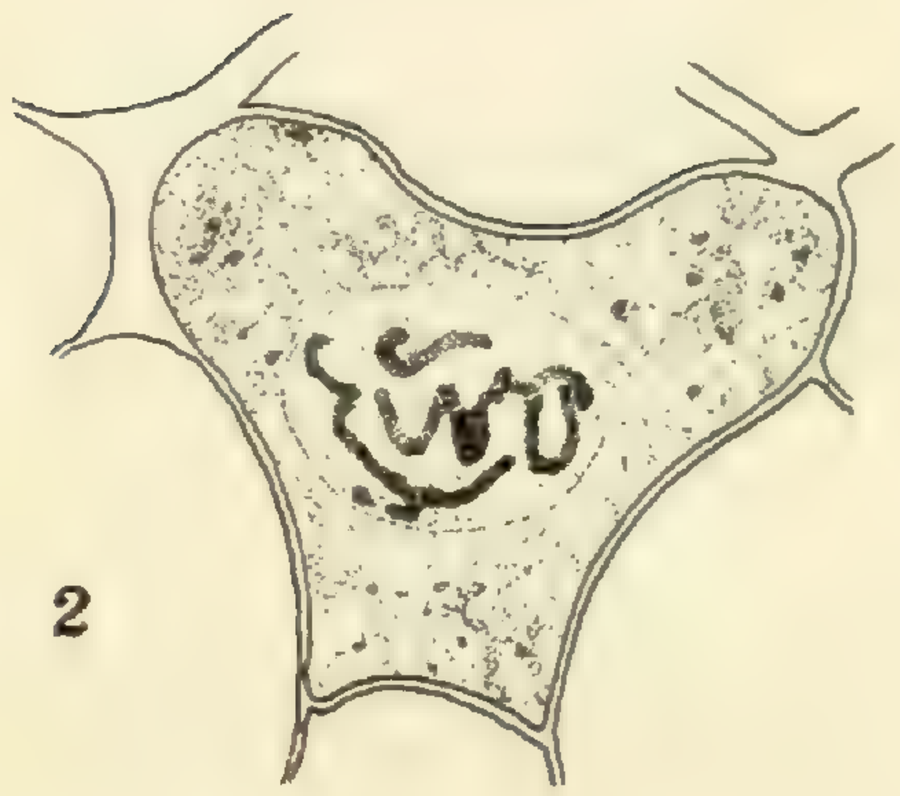

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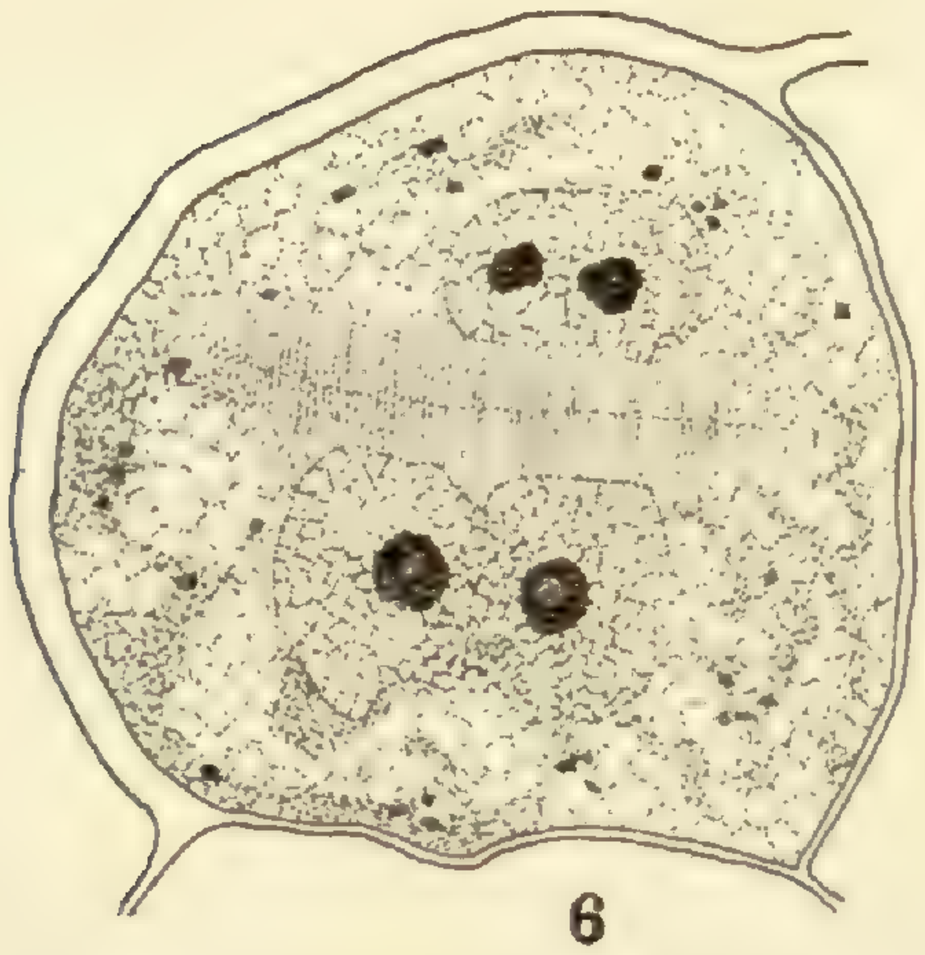

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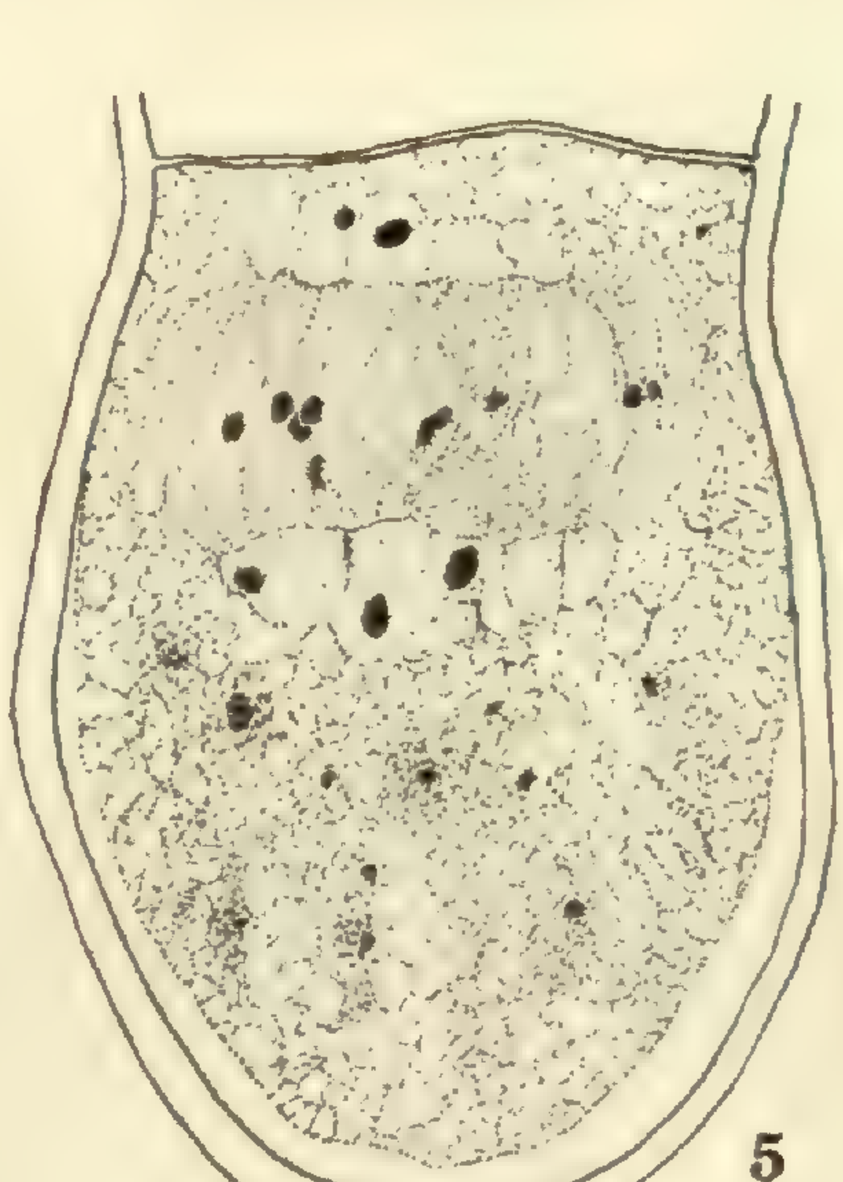

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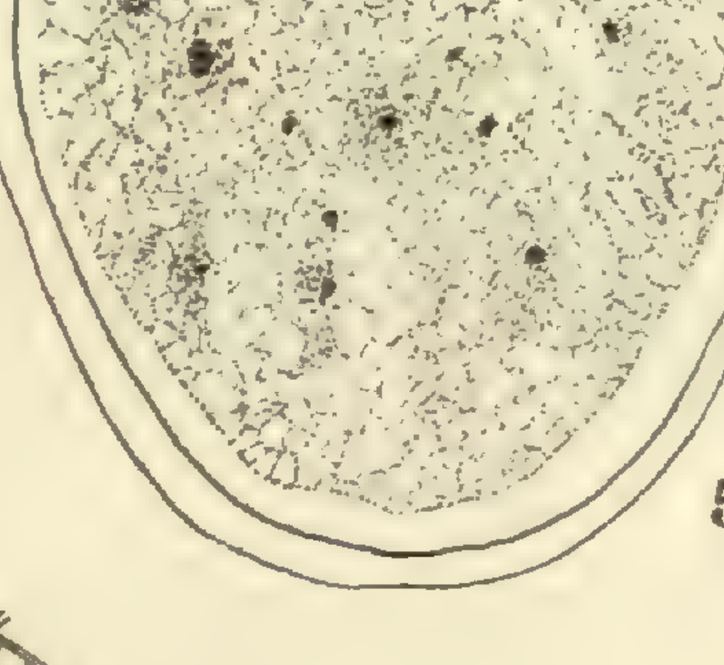

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RIKER: CHONDRIOMES IN CHARA

Vol. 48 No. 6

BULLETIN

OF THE

TORREY BOTANICAL CLUB

JUNE, 1921

Notes on Rosaceae—XIII

PER AXEL RYDBERG

ROSES OF THE COLUMBIA REGION

In this region I here include the states of Oregon and Washington, together with British Columbia and northern Idaho. Most important are the roses of the Cascade Mountains. In the northern part many of the species of the Rocky Mountains have invaded the region, not only on the western slopes of the Rockies but also in the Cascades; in the Siskiyou Mountains of southwestern Oregon there are also found some Californian species; and in eastern Oregon some of those belonging to the Great Basin are found. Since my revision in the North American Flora we have received in exchange a collection from British Columbia, from the Geological Survey of Canada; and Professor J. K. Henry of the University at Vancouver has sent in another collection for determination. Also, I have seen collections from southeastern Oregon made by Miss Eastwood and Dr. Rehder for the Arnold Arboretum.

Key to the groups of species

Styles much exserted, about equaling the stamens; stipules adnate; sepals reflexed, deciduous: styles united; stem climbing, with curved prickles. I. SYNSTYLAE.

Styles not exserted, or only slightly so: stigmas forming a head closing the mouth of the hypanthium.

Pistils numerous; styles as well as the upper part of the hypanthium persistent.

[The Bulletin for May (48: 141–158. *pl. 3*) was issued May 25, 1921.]

Stem climbing, with scattered prickles, rarely with intermixed bristles; sepals more or less lobed; foliage glandular-punctate, sweet-scented. II. CANINAE.

Stem not climbing, at least the young shoots bristly; prickles infra-stipular or lacking; sepals entire or the outer sometimes with one or two lobes; foliage not very sweet-scented. III. CINNAMOMEAE.

Pistils few; styles deciduous with the upper part of the hypanthium, which falls off like a ring. IV. GYMNOCARPAE.

I. SYNSTYLAE

Stipules pectinately lobed and glandular-ciliate; corymb many-flowered. 1. *R. multiflora.*

Stipules merely serrate; corymb one- to few-flowered. 2. *R. arvensis.*

1. ROSA MULTIFLORA Thunb.

See my notes in the preceding paper of this series.* The species has been reported as a ballast plant at one station in Washington.

2. ROSA ARVENSIS Huds.

The following specimens were sent to me by J. C. Nelson, principal of the high school at Salem, Oregon, for determination. In the accompanying letter Mr. Nelson wrote among other things: "He [the collector] reports this form as common in the vicinity of Vancouver [Washington], apparently fully spontaneous. The flowers were always single, and the petals of a wonderful shade of pearly white." The specimens apparently belong to the so-called Ayrshire Rose, which is by some regarded as a form of *R. arvensis*, by others as a hybrid of the same. The leaflets are larger and more pointed and the sepals more inclined to be lobed than in the wild English form of that species.

WASHINGTON: Vancouver, *R. V. Bradshaw 1053*.

II. CANINAE

Leaflets suborbicular or broadly oval, mostly rounded at the apex; hypanthium in fruit obovoid or broadly ellipsoid, abruptly contracted at the apex; sepals tardily deciduous or persistent. 3. *R. rubiginosa.*

Leaflets ovate or oval, acute or short-acuminate; hypanthium in fruit narrowly ellipsoid, tapering at both ends; sepals early deciduous; styles glabrous or nearly so. 4. *R. micrantha.*

* Bull. Torrey Club 47: 47. 1920.

3. ROSA RUBIGINOSA L.

The European sweet brier, often cultivated, has established itself at several places in Oregon and Washington. It is very variable and the naturalized specimens show also much variation. One of these many forms, which is rather more glandular than usual, was mistaken for a native species and published by Dr. E. L. Greene as new, under the name *R. Walpoleana*. The author placed it in the GYMNOCARPAE, a group to which it has no relation.

4. ROSA MICRANTHA Borrer

See Bull. Torrey Club **47**: 49. 1920. This species also is naturalized in Oregon and Washington.

III. CINNAMOMIAE

Infra-stipular prickles not present; branches unarmed or bristly, not prickly.	
Stem densely bristly even in age; flowers solitary.	
Hypanthium decidedly pear-shaped or ellipsoid, acute at the base, with a distinct neck at the top.	
Sepals rarely more than 1 cm. long; bark yellowish green.	5. *R. collaris.*
Sepals 2–3 cm. long; bark brown.	
Leaflets obovate, sparingly hairy beneath.	6. *R. Butleri.*
Leaflets elliptic, densely pubescent beneath.	7. *R. acicularis.*
Hypanthium subglobose, almost without a neck.	8. *R. Bourgeauiana.*
Stem unarmed or when young covered with more or less deciduous bristles; flowers corymbose.	
Fruit ellipsoid; leaflets serrate.	32. *R. Pringlei.*
Fruit subglobose; leaflets crenate.	9. *R. anacantha.*
Infra-stipular prickles present.	
Flowers mostly solitary; petals usually 2.5 cm. long or more (except in No. 11); hypanthium in fruit 12–20 mm. thick.	
Prickles straight or nearly so.	
Hypanthium densely prickly.	10. *R. MacDougalii.*
Hypanthium not prickly or rarely slightly so.	
Leaflets more or less double-toothed, more or less glandular-granuliferous beneath; stipules and rachis glandular.	
Pedicels and calyx densely bristly but hypanthium glabrous; leaflets oval, rarely 2 cm. long; prickles weak; petals 15 mm. long.	11. *R. yainacensis.*
Pedicels and calyx not bristly, sometimes slightly glandular-hispid.	

Leaves very thin, pale and slightly glandular-puberulent, but not muriculate beneath. 12. *R. Nutkana.*

Leaves thicker, dark green on both sides, conspicuously glandular-muricate beneath. 13. *R. muriculata.*

Leaflets simple-toothed, puberulent beneath, but not glandular-granuliferous or -muricate; rachis rarely glandular. 14. *R. Spaldingii.*

Prickles more or less curved.

Prickles very large, flat, pubescent; twigs densely glandular and pubescent. 15. *R. Durandii.*

Prickles slender, glabrous, not conspicuously flattened; twigs not conspicuously glandular, mostly glabrous.

Sepals not glandular-hispid; leaflets 2–4 cm. long, not conspicuously glandular double-toothed. 16. *R. columbiana.*

Sepals conspicuously glandular-hispid; leaflets 1–2 cm. long. conspicuously glandular double-toothed. 17. *R. myriadenia.*

Flowers mostly corymbose, if solitary the petals 2 cm. long or less; fruit rarely more than 1 cm. in diameter.

Prickles more or less curved.

Leaflets softly villous beneath; prickles stout, flattened; hypanthium with a neck. 18. *R. californica.*

Leaflets very finely puberulent and somewhat glandular-pruinose beneath; prickles not flattened; hypanthium without a distinct neck.

Leaflets with simple teeth, not copiously glandular-pruinose beneath. 19. *R. puberulenta.*

Leaflets with double gland-tipped teeth, conspicuously glandular-puberulent beneath. 20. *R. delilescens.*

Prickles straight or nearly so.

Hypanthium normally neither prickly or bristly.

Hypanthium globose; neck usually obsolete.

Sepals lanceolate, with long, caudate-attenuate or sometimes foliaceous tips, more than 1 cm. long.

Stipules, petiole, and rachis copiously glandular; leaflets double-toothed, with gland-tipped teeth, densely glandular-pruinose or muriculate beneath.

Leaflets orbicular or rounded oval. 13. *R. muriculata.*

Leaflets oblong to oval. 22. *R. Fendleri.*

Stipules, petiole, and rachis not glandular or the stipules slightly glandular-dentate.

Leaflets glabrous or nearly so.
Leaflets broadly oval, 3–5 cm. long. 21. *R. rivalis.*
Leaflets obovate or elliptic, rarely 3 cm. long. 23. *R. Woodsii.*
Leaflets more or less pubescent beneath.
Leaflets villous or pilose beneath, rounded or broadly oval. 25. *R. myriantha.*
Leaflets finely puberulent beneath.
Leaves obovate, more or less pale or glaucous beneath; prickles comparatively long, spreading. 24. *R. Macounii.*
Leaflets elliptic or oval, equally green on both sides; plant with few short ascending prickles.
Sepals decidedly glandular; leaflets thin and soft. 26. *R. pisocarpa.*
Sepals not glandular, or slightly so on the margins; leaflets rather thick. 27. *R. ultramontana.*
Sepals ovate, less than 1 cm. long, not conspicuously caudate; leaflets simple-toothed; puberulent beneath. 28. *R. Covillei.*
Hypanthium elongate with a distinct neck; leaves finely puberulent beneath.
Leaflets light green, coarsely toothed; hypanthium in fruit pyriform. 31. *R. pyrifera.*
Leaflets dark green above, finely toothed; hypanthium in fruit ellipsoid.
Plant unarmed or nearly so; fruit 1 mm. broad. 32. *R. Pringlei.*
Plant with slender prickles; fruit 6–8 mm. broad. 33. *R. Eastwoodiae.*
Hypanthium densely bristly or prickly; leaflets orbicular in outline.
Leaflets subsessile. 29. *R. spithamea.*
Leaflets with petiolules, 1–4 mm. long. 30. *R. adenocarpa.*

5. ROSA COLLARIS Rydberg

The following specimens are doubtfully referred to this species: WASHINGTON: Fort Colville, 1880, *S. Watson 123*.

6. ROSA BUTLERI Rydberg

This species belongs to the Rocky Mountain region and was originally described from northwestern Montana. The following specimens from British Columbia are referred here:

BRITISH COLUMBIA: Camloops, May 24, 1912, *A. Thorpe.*

7. ROSA ACICULARIS Lindl.

See Bull. Torrey Club. **47**: 56. 1920. This is a common species throughout the northern Rockies and the Cascade Mountains.

8. ROSA BOURGEAUIANA Crépin

See notes in Bull. Torrey Club **47**: 57. 1920. In the Columbia region, this species has been found only north of the Canadian boundary.

BRITISH COLUMBIA: Okanogan Landing, Golden, *Pense;* Skeena River, *J. K. Henry.*

9. ROSA ANACANTHA Greene

This species is related to the eastern *R. blanda*, but differs in the crenate instead of serrate leaflets and the smaller fruit. It is known only from the type locality, in salt marshes near Tacoma, Washington.

10. ROSA MACDOUGALII Holz.

This is regarded by many as a form of *R. Nutkana*. It differs not only in the hispid fruit but also in the fact that the teeth of the leaflets are seldom double as they are in *R. Nutkana* and the leaflets are rarely glandular-granuliferous. Neither could it be referred as a form of *R. Spaldingii*, for in the latter the leaflets are pubescent beneath. The following specimens belong here:

IDAHO: Landing-Cuprum road 1901, *Cusick 2533, 2352;* Farmington Landing, 1892, *Sandberg, MacDougal & Heller 572, Heller 3256.*

OREGON: Rye River Valley, *Leiberg 4410.*

WASHINGTON: Pullman, 1896, *Elmer 72, 74.*

11. ROSA YAINACENSIS Greene

Until lately this species was known only from the type locality. The habit, long prickles, and large fruit suggest *R. Nutkana*, but

it is unique in the group on account of its densely glandular-bristly pedicels. It evidently is a good species unless of hybrid origin. It might have been produced by *R. Nutkana* and *R. gymnocarpa*.

OREGON: Yainax Indian Reservation, *Mrs. Austin*.

CALIFORNIA: Crescent City, Del Norte County, 1912, *Eastwood 2270*.

12. ROSA NUTKANA Presl

Although an easily distinguished species (except from the two next following species), it has been mistaken for *R. fraxinifolia* (i.e. *R. blanda*) and *R. Woodsii*. It has also been named *R. caryocarpa* Dougl. and *R. Lyalliana* Crépin; but these names have not been published, except in synonymy.

13. ROSA MURICULATA Greene

This is closely related to *R. Nutkana* and is perhaps not distinct. It differs in the thicker and smaller leaves, densely glandular-muricate beneath, and in the often corymbose inflorescence. As it is more common on the Vancouver Island than the preceding species, there may be a possibility that it is the original *R. Nutkana* Presl. In such a case the plant known as that species would be without a published name.

14. ROSA SPALDINGII Crépin

This has been confused with *R. Nutkana* but differs in the simple-toothed leaflets, which are decidedly pubescent but scarcely at all glandular-granuliferous beneath. Dr. Watson merged it in *R. Nutkana*, and this fact probably influenced Crépin to withdraw his species. The plant had been recognized before: Borrer in Hooker's Flora included it in *R. cinnamomea*, which it approaches more than any other American species does, differing principally in the longer and straight prickles; Nuttall recognized it as a species, *R. megacarpa*, but this name was published only as a synonym in Torrey & Gray's Flora; in the meantime Rafinesque had published it as *R. macrocarpa* Nutt. It is common through the northern Rockies as well as the Cascades.

15. ROSA DURANDII Crépin

This was based on *E. Hall 146*, which was referred to *Rosa kamtschatica* by Dr. Gray. Dr. Watson in his monograph reduced it to a synonym of *R. Nutkana*. Crépin, probably influenced by Watson's treatment, later retracted his species. In my opinion *R. Durandii* is perfectly distinct from *R. Nutkana*. The leaves are thicker, more hairy than in that species, and rarely double-toothed; the prickles are not like those of *R. Nutkana*, but curved, short, strongly flattened and pubescent. As long as only Hall's specimens were known, the specimens might have been regarded as freaks, but specimens almost exactly like these have since been collected.

OREGON: *E. Hall 146;* Brownville, 1895, *Canby;* near Springfield, *Coville & Applegate 1076.*

BRITISH COLUMBIA. Queen Charlotte's Island, *Dawson 8144* (?).

IDAHO: Lower Priest River, *Leiberg 2883*. This specimen is very peculiar, nearly unarmed, but with the pubescence of the leaves and twigs of *R. Durandii.*

16. ROSA COLUMBIANA Rydberg

This also is related to *R. Nutkana* but differs in the strongly curved prickles. It is a rather local plant, the following specimens belonging here:

IDAHO: Little Potlatch River, 1892, *Sandberg, MacDougal & Heller 381;* Kooteney County, *Sandberg.*

OREGON: Forest Grove, 1893 and 1894, *Lloyd.*

17. ROSA MYRIADENIA Greene

This species has the habit, toothing, and glandular pubescence of *R. muriculata*, but the leaflets are smaller and the prickles are decidedly curved; these characters would place it in the key next to *R. columbiana*. From this it differs in the smaller and more pubescent leaves. It is known only from the type locality, Huckleberry Mountains, Jackson County, Oregon.

18. ROSA CALIFORNICA Cham. & Schlecht.

This Californian species has been collected in the extreme southern part of Oregon.

19. ROSA PUBERULENTA Rydberg

This species belongs to the Great Basin and is related to *R. arizonica* and *R. neomexicana*. The following specimens are referred here, though somewhat doubtfully:

WASHINGTON: Wilson Creek, *Sandberg & Leiberg;* Rattlesnake Mountains, *Cotton 469.*

OREGON: Antelope Creek, *Applegate 2399;* Cold Spring, *Coville & Applegate 1122;* Wallowa, *Samson & Pearson 78.*

20. ROSA DELITESCENS Greene

This is related to *R. californica* but characterized by the double-serrate leaflets, glandular-pruinose beneath and with gland-tipped teeth, and by the subglobose fruit. It is known only from the type locality in the Siskiyou Mountains, Oregon.

21. ROSA RIVALIS Eastwood

This species belongs to the Californian flora (see notes, Bull. Torrey Club **44**: 74. 1917) but the following specimen has been collected in Oregon:

OREGON: Cold Spring, Crook County, 1898, *Coville & Applegate 131.*

22. ROSA FENDLERI Crépin

23. ROSA WOODSII Lindl.

24. ROSA MACOUNII Greene

These three species belong to the Rocky Mountain region but extend west into the Cascade Mountains. They will be treated in a subsequent paper.

25. ROSA MYRIANTHA Carr.

This is primarily a Californian rose (see notes, Bull. Torrey Club **44**: 75, 76. 1917), but the following specimens belong here:

OREGON: Barlow Gate, *Lloyd;* lower Albina, Portland, *Sheldon 10659;* Wimmer, *Hammond 119*, in part.

26. ROSA PISOCARPA A. Gray

27. ROSA ULTRAMONTANA (S. Wats.) Heller

These two species have been treated previously, under the Roses of California and Nevada (see Bull. Torrey Club **44**: 77, 78. 1917). Though the former has its best development in the

Columbia region, especially west of the Cascades and the latter in the northern part of the Great Basin, which includes eastern Oregon, both extend north into British Columbia.

28. ROSA COVILLEI Greene

This species and *R. Bolanderi* are characterized among the cinnamon roses by the short ovate, short-acuminate sepals. *R. Covillei* is known only from the type locality, near Naylor, Klamath County, Oregon.

29. ROSA SPITHAMAEA S. Wats.

This species of northern California has been collected at one locality in the Columbia region:—

OREGON: Wimmer, *Hammond 120.*

30. ROSA ADENOCARPA Greene

Notwithstanding Dr. Greene's remark, "despite all its peculiar characteristics, a genuine member of this gymnocarpa group," I am compelled to exclude it. The upper part of the hypanthium and calyx show no sign of being deciduous, the sepals are not those short ones of the *R. gymnocarpa* allies, and the hypanthium is bristly. These characters and the dwarf herbaceous stems indicate that the plant is related to *R. spithamaea*, where I have placed it. It is known only from the type locality, Mt. Grayback, southwestern Oregon.

31. ROSA PYRIFERA Rydberg

This species is related on one hand to *R. Macounii* and on the other to *R. ultramontana* and *R. pisicarpa*, but differs from them all in the pear-shaped hypanthium, which has a more distinct neck. It is common in the northern Rockies, but the following specimens are from the Columbia region:—

WASHINGTON: Clarks Spring, *Kraeger 47.*

OREGON: Powder River Mountains, 1896, *Piper;* Horse Creek Canyon, *Sheldon 8138;* Thompson Creek, *Brown 86;* Ashland, *Walpole 375;* Tygh Valley, *Walpole 336;* Cow Creek, *Coville 1162;* Blue Mountains, *Cusick 1697.*

32. ROSA PRINGLEI Rydberg

See notes, Bull. Torrey Club 44: 79. 1917. The following specimens are from the region:

OREGON: Wallowa River, 1897, *Sheldon 8687* (?).

WASHINGTON: Klickitat County, 1885, *Suksdorf*.

BRITISH COLUMBIA: Armstrong Pass, 1912, *E. Wilson;* Elgin, *Miss Edstrom*.

33. ROSA EASTWOODIAE Rydberg

This is related to *R. Pringlei* but the plant has smaller leaves, smaller flowers and fruit, and is usually prickly. The fruit is only 6–8 mm. in diameter. To this belong:—

CALIFORNIA: Sisson, Siskiyou County, 1912, *Eastwood 2100*, mainly.

OREGON: Waldo, Josephine County, 1912, *Eastwood 2168*.

IV. GYMNOCARPAE

Leaves glabrous beneath.

Flowers mostly 2–4 together, leafy-bracted; upper stipules broadly dilated; leaflets with broadly ovate teeth, indistinctly reticulate beneath; fruit 6–8 mm. broad. 37. *R. dasypoda.*

Flowers usually solitary, not leafy-bracted; stipules narrow; leaflets with lanceolate or ovate lanceolate teeth; fruit 6 mm. in diameter or less.

Leaves not very thin, pale and indistinctly reticulate beneath; sepals 1–1.5 cm. long. 35. *R. leucopsis.*

Leaves very thin, scarcely paler on the lower surface, which is distinctly reticulate with semi-pellucid veinlets; sepals less than 1 cm. long.

Leaflets 5–7, usually more than 1.5 cm. long; teeth ovate-lanceolate in outline; terminal leaflet usually rounded at the base. 34. *R. gymnocarpa.*

Leaflets 7–9, usually less than 1.5 cm. long, the terminal one usually acute or cuneate at base; teeth lanceolate in outline. 36. *R. prionota.*

Leaves pubescent beneath. 38. *R. Bridgesii.*

34. ROSA GYMNOCAPRA Nutt.

This species is one of the most common roses in the Columbia region (see my notes, Bull. Torrey Club 44: 82. 1917). As stated there Dr. Greene described twelve species belonging to the group and some of these will be discussed here.

Rosa glaucodermis Greene. Dr. Greene pays especial attention

to the ashy gray bark and the petioluled leaflets, characters which I think are not distinctive. In the typical *R. gymnocarpa* the bark is often light in color on old stems, and many specimens from the range of the typical *R. gymnocarpa* have more or less petioluled leaflets, such as *Jones 1088* and *R. S. Williams 876* from Montana, *Sheldon 8521* from Oregon, and *Allen 72* from Washington. I therefore regard this as a synonym of *R. gymnocarpa*.

Rosa abietorum Greene, I take as an unusually bristly *R. gymnocarpa*. I have been unable to find any constant character.

Rosa amplifolia Greene. I have not been able to distinguish this from *R. gymnocarpa*. Dr. Greene's remarks, "the leaves are so very large and have so much the color, texture and pattern of *R. acicularis*, that but for the small solitary flowers this would have passed readily with many for that species," are at least confusing. *R. acicularis* has rather thick, elliptic leaflets, decidedly pubescent beneath. Dr. Greene must have had an erroneous idea of *R. acicularis*.

35. ROSA LEUCOPSIS Greene

This is so close to *R. gymnocarpa* that I hesitated to admit it as a species. In *R. gymnocarpa* and *R. prionota* the leaflets are very thin and reticulate with semi-pellucid veins. In *R. leucopsis* the leaves are not so thin and the veins are faint and not at all pellucid. Otherwise the three plants are very similar. The species was described from fruiting material; the plant becomes paler in age.

Rosa Helleri Greene is evidently the same plant in flowers and shows only slight variation from the type of *R. leucopsis*. The Idaho specimens are mostly like those of the type of *R. Helleri*, but two numbers of Sandberg, MacDougal & Heller are almost identical with the type of *R. leucopsis*.

36. ROSA PRIONOTA Greene

This has been discussed before (see Bull. Torrey Club 44: 32. 1917).

Rosa piscatoria Greene I regard as an unusually strong and bristly plant of *R. prionota*.

Rosa apiculata Greene was so named on account of the form

of the fruit, "which is elongated, fully twice as long as broad, ending in a narrow necklike apiculation." The type sheet bears eight fruits. Of these only four are twice as long as broad, three are ellipsoid, but not as long, and one is nearly globose, slightly pear-shaped; four of them (three of the longer and one of the short-ellipsoid ones) have a conspicuous neck; one of the short-ellipsoid ones has no neck and the other three a short one. Miss Cooley's specimens from Vancouver Island, which from the locality should belong to this species and which agree with it in all respects except the fruit, has three fruits. One of these is elongated-ellipsoid, one somewhat pear-shaped and one subglobose; all with obsolete neck. They cannot be distinguished from *R. prionota*.

To *R. prionota* belongs the following specimens from the Columbia region:

WASHINGTON: Whiddley Island, *Saunders* (type of *R. apiculata*).

BRITISH COLUMBIA: Nanaino, *Miss Cooley*.

36. ROSA DASYPODA Greene

See notes, Bull. Torrey Club **44**: 83. 1918. To this species belong the following specimens:

OREGON: Wallowa County, *Sheldon 8815* and several other numbers; Siskiyou Mountains, *Applegate 2251;* without locality, *E. Hall 143;* Toledo Canyon, *Rusby;* Wimmer, *Hammond 117*.

WASHINGTON: Chehalis County, *Heller 3897*.

BRITISH COLUMBIA: Chilliwack Valley, *Macoun 79841, 24748;* between Kettle and Columbia River, *Macoun 64008, 64007;* Esquimalt, *Macoun 79840*.

37. ROSA BRIDGESII Crépin

See Bull. Torrey Club **44**: 83. 1917. To this species belong the following:—

OREGON: between Union Creek and Whiskey Creek, *Applegate 2622;* Huckleberry Mountains, *Coville 1434*.

HYBRIDS

The following hybrids have been recorded from this region:—

ROSA ACICULARIS × FENDLERI

BRITISH COLUMBIA: Golden, *J. K. Henry*.

ROSA ACICULARIS × MURICULATA

BRITISH COLUMBIA: Narramantha, Lake Okanogan, *J. K. Henry*.

ROSA BOURGEAUIANA × MURICATA

BRITISH COLUMBIA: Hazelton, Skeena River 1915, *J. K. Henry*.

ROSA GYMNOCARPA × NUTKANA

BRITISH COLUMBIA: Crescent 1915, *J. K. Henry*.

ROSA NUTKANA × PISOCARPA

BRITISH COLUMBIA: Savannas, 1892, *F. E. Lloyd*.

ROSA PISOCARPA × SPALDINGII

EASTERN OREGON: 1900, *Cusick 2418*.

ROSA GYMNOCARPA × PISOCARPA

OREGON: Siskiyou Mountains, 1904, *Render*.

ROSA GYMNOCARPA × MURICULATA

BRITISH COLUMBIA: Cameron Lake, Vancouver Island, 1912, *J. K. Henry*.

ROSA GYMNOCARPA × WOODSII

BRITISH COLUMBIA: Skeena River 1915, *J. K. Henry*.

NEW YORK BOTANICAL GARDEN

On the gross structure of an agar gel

CORNELIA LEE CAREY

(WITH FOUR TEXT FIGURES)

In connection with some other work on the behavior of agar gels a peculiar appearance was noticed in certain dried strips of agar which had been swollen in water. In these cases the swollen gels, when removed from the water, would exude a considerable amount of the adsorbed liquid under slight pressure. This led to an examination under the microscope, where it was found that the gel had a decided lamellated structure. Later it was noticed that these lamellations were visible to the naked eye and could be seen when light was reflected upon the cut surface. It seemed of interest to investigate some of the causes influencing the formation of this structure, and the relation its appearance might bear to the concentration of the gel.

A brief notice of this phenomenon has already been published in D. T. MacDougal's recent contribution on hydration and growth* from data supplied by the writer.

The method of preparing the agar was that used by MacDougal and described by him in this paper, except that silk was used to cast the agar upon instead of filter paper, as the former could be more easily removed from the agar than the latter. Prepared in this way, the gels were at first allowed to stand over night in the room, and then dried at a temperature of about 70° C. It was found, however, that this first slower drying in the room had no effect on the structure, as gels put immediately into the dryer as soon as set had the same appearance. It is, of course, to be understood that the lamellations did not appear until the dried gel had been again swollen in water.

In order to ascertain whether the tension due to the drying on the silk had anything to do with the structure of the gel, a 2.5 per cent gel was cast as usual, but instead of being stretched on a frame it was cut into strips as soon as set. Some of these were

* Hydration and growth. Carnegie Inst. Washington Pub. No. 297, 1920.

hung up in the drier; others laid horizontally on the trays in the same at temperatures of about 43° C. and 70° C. Both of these showed the characteristic structure on swelling. Similar gels were dried at room temperature, 21–25° C., both stretched on frames and cut into strips. Some of the latter were either suspended or laid horizontally across supports. None of these showed any structure at all when soaked in water and sectioned, but were homogeneous throughout. A few of the gels dried at room temperature showed slight lamellations in places on the under side of the gel near the silk, but this was not so in all cases. It is apparent from the above, that the temperature and therefore perhaps the speed of drying may be an important factor in producing this lamellated structure.

Gels of varying per cents of agar content were employed for this work, from 0.5–10 per cent. They all showed structure when dried at 70° C. A 0.25 per cent gel was tried but was too weak to set at room temperature. The following concentrations of gels, expressed in per cent content of dry powdered agar, were used: 0.5, 0.75, 1, 1.5, 2.5, 3, 4, 5, 7.5, 8, and 10 per cent. The 4 per cent gel was used to determine the point at which structure appeared as loss of water proceeded.

It seems probable that this structure must form when a certain water concentration is reached in the drying of the gel. In order to ascertain at about what concentration the formation of structure began and was complete, a 4 per cent agar gel was made and, when set, cut into pieces four by two and a half inches. Each piece was placed between a pair of tin frames which were held together by two elastic bands. Each frame had two holes in it one by one and a half inches. The whole apparatus with the agar was then put in the drier, for varying lengths of time, at a temperature of about 90° C. It was turned over at short intervals so that loss of water would be equalized on the two sides. The slices did not split during the process and were removed very easily from the frames. A portion of the pieces was cut off and put into distilled water; the other part weighed, put back into the drier and finally dried to constant weight in a calcium chloride desiccator. The part put into the water was sectioned after about twenty-four hours to see if there was any structure present.

TABLE I

PER CENT BY WEIGHT OF WATER AND AGAR IN A 4 PER CENT AGAR GEL WHEN NO STRUCTURE PRESENT

Weight of gel when removed from drier in grams	Final weight of gel in grams	Weight of water in piece when removed from drier	Per cent of water to total weight	Per cent of agar to total weight
2.254	.177	2.077	92.15	7.85
3.092	.221	2.871	92.88	7.12
2.692	.194	2.498	92.79	7.21
			92.61	7.39

TABLE II

PER CENT BY WEIGHT OF WATER AND AGAR IN A 4 PER CENT AGAR GEL WHEN STRUCTURE BEGINS

Weight of gel when removed from drier in grams	Final weight of gel in grams	Weight of water in gel when removed from drier	Per cent of water to total weight	Per cent of agar to total weight
2.331	0.181	2.150	92.24	7.76
2.351	.170	2.181	92.77	7.23
3.252	.208	3.044	93.60	6.40
1.512	.157	1.355	89.62	10.38
2.172	.172	2.000	92.08	7.92
1.959	.172	1.787	91.22	8.78
2.174	.186	1.988	91.44	8.56
			91.85	8.15

TABLE III

PER CENT BY WEIGHT OF WATER AND AGAR IN A 4 PER CENT AGAR GEL WHEN STRUCTURE IS COMPLETE

Weight of gel when removed from drier in grams	Final weight of gel in grams	Weight of water in gel when removed from drier	Per cent of water to total weight	Per cent of agar to total weight
0.306	0.235	.071	23.20	76.80
.245	.165	.080	32.65	67.35
.322	.223	.099	30.74	69.26
.289	.203	.086	29.75	70.25
.292	.225	.067	22.95	77.05
.268	.225	.043	16.04	83.96
.234	.209	.025	16.83	83.17
.215	.175	.040	18.60	81.40
.209	.196	.013	6.22	93.78
.264	.195	.069	26.14	73.86
.210	.206	.004	1.91	98.09
.279	.199	.080	28.67	71.33
.241	.219	.022	9.13	90.87
.321	.201	.120	37.38	62.62
.327	.211	.116	35.47	64.53
.306	.212	.094	30.72	69.28
.257	.177	.080	31.13	68.87
.357	.219	.038	10.64	89.36
.210	.206	.004	1.90	98.10
.235	.178	.057	24.26	75.74
			21.72	78.28

From the larger piece, which was dried to constant weight, the per cent of water in the gel at the given time was obtained. This gave a fairly accurate estimate of the relation of water content to structure but cannot be regarded as strictly quantitative, as the electric heater did not give a wholly uniform temperature over all the drier so that when the time factor is constant a slight difference in the position of the strips when in the oven might vary the concentrations in them.

The tables on page 175 show the per cent by weight of water and agar in the gels: (*a*) when there was no structure present; (*b*) when it first began to appear; and (*c*) when the structure was complete. From comparison of TABLES I and II it will be seen that the critical point for structure formation lies between about 92 per cent and 92.5 per cent water content. This, however, is not the uniform concentration throughout the piece, since the surface would of course lose water first and the water content in the center of the gel would be higher than that on the edge, as it dries from the outside in and from the edge of the frame toward the center. The structure, as one would suppose, starts from the outside of the block and goes inward. This would necessarily be the way since the surface loses water first. The structure was complete, as shown in TABLE III, when the gel contained about 21.5 per cent by weight of water.

For the purposes of this paper the agar dried to constant weight in the desiccator was assumed to contain no water. The basis of the calculations was as follows: the per cent of water by weight to the total weight of substance was calculated by subtracting the final (constant) weight, obtained by drying the pieces of agar in a calcium chloride desiccator, from the first weight, after drying varying lengths of time in the oven. The loss of weight was therefore the per cent of water in the gel when structure became apparent. The pieces gained somewhat in weight while in the desiccator due to the vapor pressure of the calcium chloride. This was not taken into account as it is a constant error in all cases.

The structure varies in the different gels but is fundamentally the same. It appears as horizontal splitting in the gel, and when very pronounced as it was in most of them, particularly those

below 7.5 per cent, has somewhat the appearance of branching; the cavities being shaped in section like a biconvex lens. In the 10, 8, and 7.5 per cent gels there were fewer large cavities and more fine pores or slits (FIG. 4). In the weaker gels larger slits and fewer finer ones are seen (FIGS. 1–3).

The figures show a gradual change from the coarser to the finer structure as the per cent of agar in the gel increases. It seems as though this change probably commenced between the 5 and the 7.5 per cent gels though this has not been definitely determined. Narrower branching also appears if the gels are dried at high tempera: tures, i.e., more rapidly. Strips not dried on the frames showed structure, but curled somewhat in drying. The 2.5, 3 and 5 per cent gels after soaking in water could be peeled off in layers.

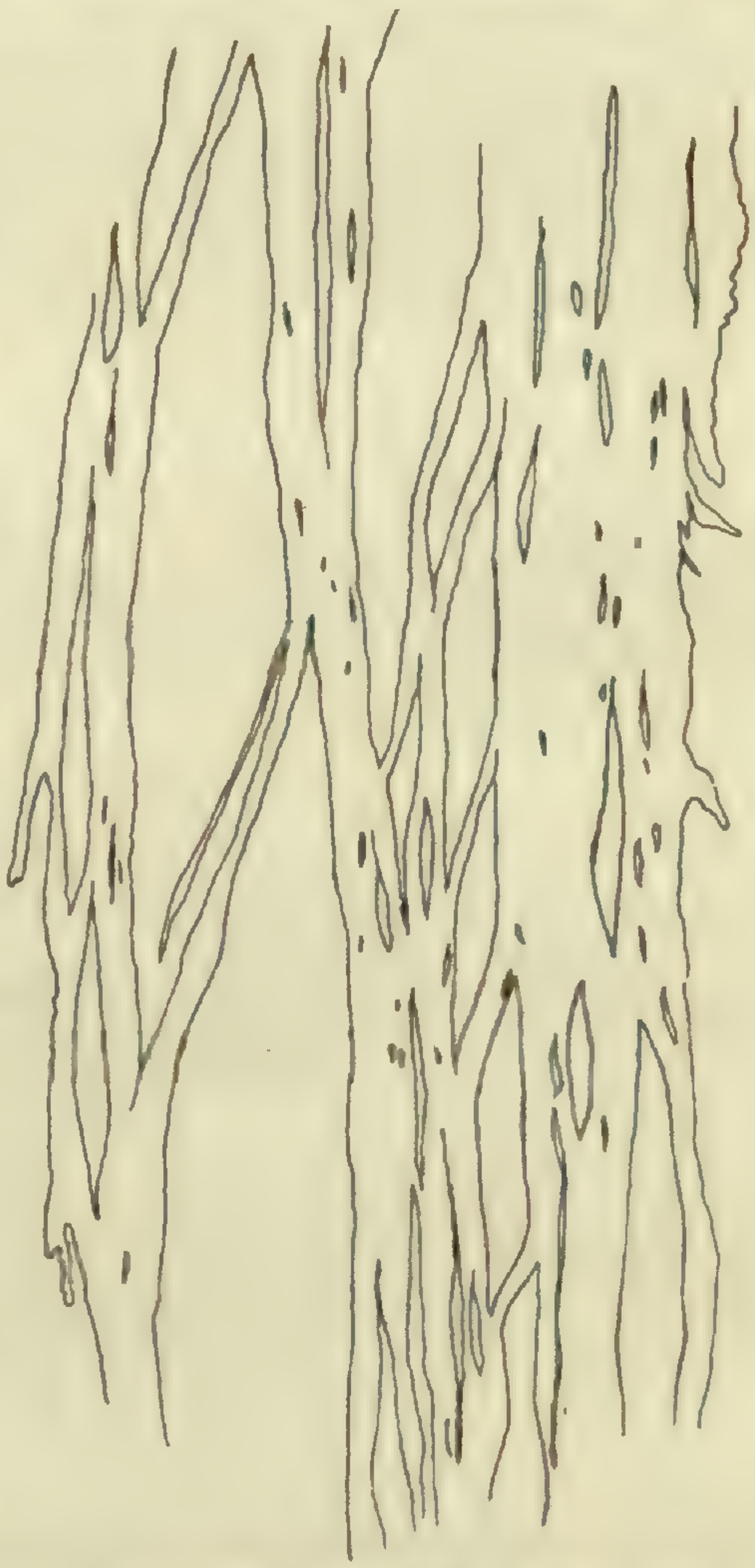

FIG. 1. A 0.5 per cent agar gel after being in water about one hour. × 57.

It seems possible that the structure of the gels, which when first set must be isotropic, becomes anisotropic on drying due to the strains set up within the mass. It would seem to the writer that the long axis of the particles, after drying, would be in the horizontal plane of the gel. This might cause splits in it in the horizontal and not in the vertical plane, as the water is withdrawn, as is the case here. This is, however, only a suggestion as the gels were not examined with a polariscope.

Ambronn* found that thin layers of agar and gelatine, when frozen and dried on glass plates, gave the appearance under the microscope of a fine network which, he says, looked almost like a

* Ber. Verhandl. Königl. Sachs. Ges. Wissens. Math. Phys. Kl. 1891: 28–31.

section of parenchymatic plant cells. He found the walls of the meshes were like those of normal cells, having a decided double refraction, and the smallest axis of the particles lying perpendicular to the surface of the partitions caused by freezing. He did not obtain this structure after freezing and drying either egg albumin or dextrin, as the glass became covered with a uniform coat of the substance. The agar and gelatine retained their structure unless heated to a high temperature.

Later Molisch,* in relation to his work on the freezing of plants, also worked on the freezing of gels. Among others he used gelatine and starch. He experimented with a 2 per cent gelatine which formed a stiff gel at room temperature. Under the microscope, at the moment of freezing, masses of ice appeared at different points which increased in size. When the ice formation had ended, a highly complicated network of gelatine remained between the ice masses. After thawing the network remained for several days as the gelatine could not adsorb the water at relatively low temperatures, and it could be fixed by treating with absolute alcohol. The starch acted in much the same manner. According to Molisch, on freezing a separation of the water and the colloid starts, in which numerous ice crystals are formed, which are enclosed by the network of the colloid. The ice is derived from the water of the gels. Such substances as white of egg, gum arabic, etc., shortly after thawing return to their original condition. Molisch compares this freezing to that of *Amoeba* and certain plant cells. He says cells may freeze like *Amoeba* and the stamen hairs of *Tradescantia*. Here the ice forms within the protoplast, which makes a network around it. Or they may freeze as *Spirogyra* and *Cladophora* do. In the latter case, the water comes out of the cell and freezes on the outside of the wall and there is a great shrinkage of the cell during the process. When cells freeze, as in the case of the colloidal gels, there is a strong dehydration since ice formation and shrinking of the protoplast go hand in hand. The spaces formed on thawing of the ice in Molisch's gelatine and starch were more spherical and less flattened than those obtained by the writer on desiccation of agar. This may be due to the shape of the ice crystals themselves, although it is

* Untersuchungen über das Erfrieren der Pflanzen. Jena. 1897.

perhaps unsafe to make a direct comparison, as Molisch did not work with agar.

FIG. 2. A 2.5 per cent agar gel after drying at about 43° C. and soaking in water, × 57.

There seems to be a similarity between the effect of rapid dehydration due to freezing and rapid drying at higher temperatures and the structure of the gel. In both cases the water is

withdrawn, but in the case of the freezing it remains as ice or water surrounded by the gel; while in the other, it is immediately removed by the high temperature at which dehydration is carried on.

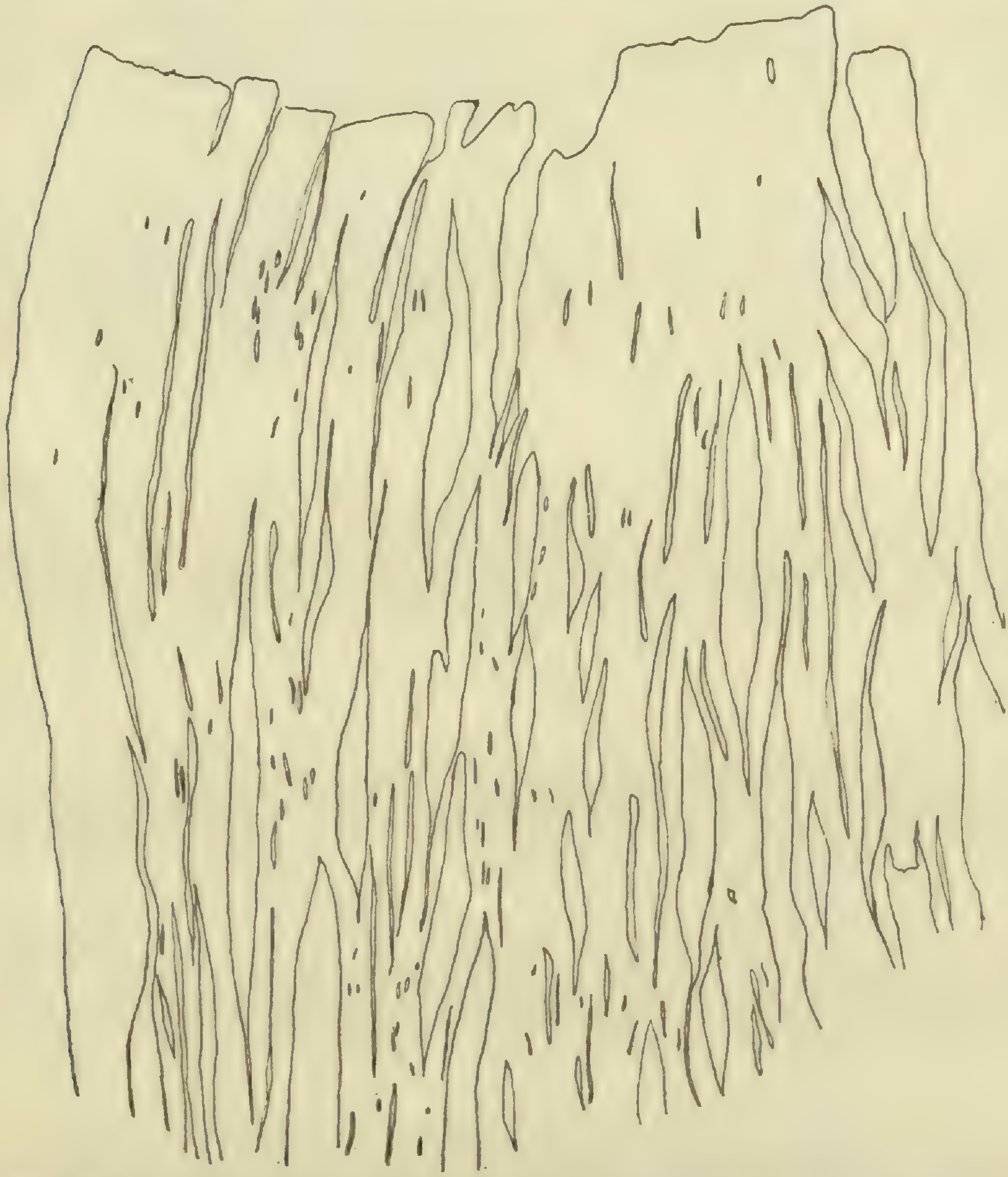

FIG. 3. A 5 per cent agar gel dried at about 70° C., after soaking in water, × 57.

If it were possible to obtain a structural colloidal gel made of a mixture of proteins and carbohydrates, one might be able to get similar results to those obtained in plant tissues, although it might be dangerous to carry this analogy too far.

The separation of colloidal fluid from gels on standing, known as syneresis, is a phenomenon which is more pronounced the

more hydrated the gel is. Fischer* accounts for the condition found in the tissues in oedema by means of syneresis, and MacDougal† considers syneresis as a means of vacuole formation after which osmotic pressure plays its part, the earlier stages being due to hydration.

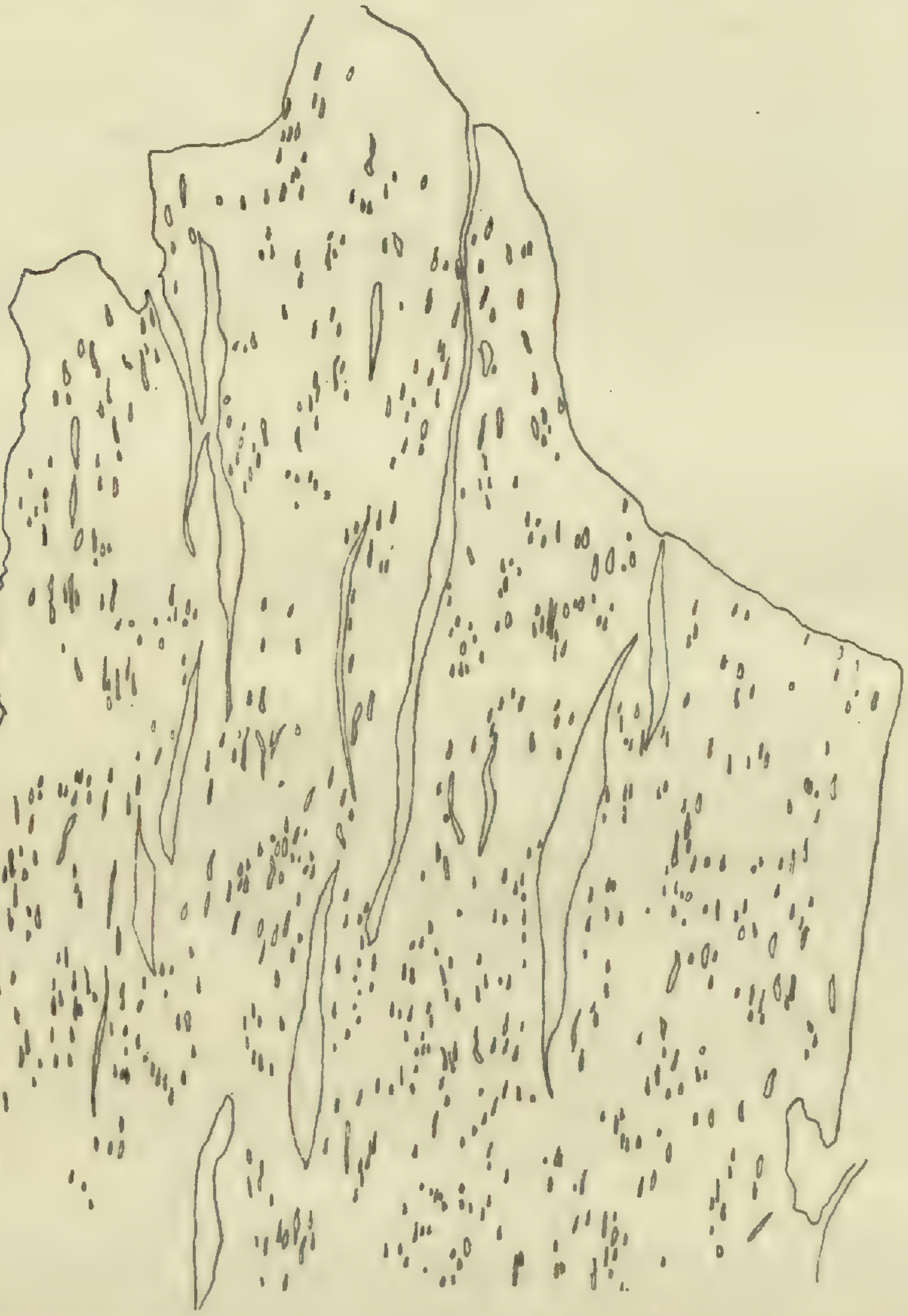

FIG. 4. A 7.5 per cent agar gel after drying at about 70° C. and soaking in water, × 57.

Zsigmondy‡ states that, if the reaction of dehydrated silicic acid gels toward hydrosols is observed under the microscope, the gel will be seen to break into small pieces. This, he says, is

* Oedema and nephritis. 1915.
† Growth in organisms. Science II. 49: 599–605. 1919.
‡ Chemistry of colloids. English edition. 1917.

due to the pressure on the air in the pores of the gel together with surface tension changes. The water enters the gel quickly at first. While this goes on explosions and splittings take place in the gel and air bubbles are formed at little cracks. As the bursting of the gel and the evolution of the air proceeds, the volume of the air spaces becomes smaller and finally disappears. He does not feel that there is any evidence of explosions with water. Zsigmondy was, of course, working with a non-elastic gel which has rather different properties of hydration and dehydration than elastic gels have.

Zsigmondy also writes that Bütschli and later work with the ultra-microscope have shown that with silicic acid gels the dehydration does not proceed from the outside of the gel inward, but that holes are formed in the interior of the gel. These holes contain no liquid. This does not seem to be the case with agar gels, when sections of the partly dehydrated gel are viewed under the microscope, as the first slits visible are near the surface of the gel.

It appears from this work that the structure of the gels is probably due to the rapidity of the drying, which in this case varied with the temperature used. All the gels showed structure except those dried at room temperature, the majority of which showed none; a few, however, showed one or two slits. The structure is not due to the strain of stretching on silk, as pieces dried suspended or laid on trays in the oven showed the same appearance. This varied somewhat in different gels, those above 5 per cent being finer. Gels of lower concentrations when dried at temperatures of 43° C. and 70° C. did not show any great difference in structure. The per cent by weight of water and agar just before and at the beginning of structure formation is not absolutely accurate, as the gel contains a higher water concentration inside than out, owing to the fact that the drying takes place from the outside inward.

I wish to express my appreciation and thanks to Dr. Herbert M. Richards for his most helpful advice and interest.

BOTANICAL LABORATORY,
BARNARD COLLEGE,
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INDEX TO AMERICAN BOTANICAL LITERATURE

1917–1921

The aim of this Index is to include all current botanical literature written by Americans, published in America, or based upon American material; the word America being used in the broadest sense.

Reviews, and papers that relate exclusively to forestry, agriculture, horticulture, manufactured products of vegetable origin, or laboratory methods are not included, and no attempt is made to index the literature of bacteriology. An occasional exception is made in favor of some paper appearing in an American periodical which is devoted wholly to botany. Reprints are not mentioned unless they differ from the original in some important particular. If users of the Index will call the attention of the editor to errors or omissions, their kindness will be appreciated.

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Peltier, G. L. Influence of temperature and humidity on the growth of *Pseudomonas Citri* and its host plants and on infection and development of the disease. Jour. Agr. Research **20**: 447–506. 15 D 1920.

Popenoe, W. The Colombian berry or giant blackberry of Colombia. Jour. Hered. **11**: 195–202. 20 Ja 1921. [Illust.]
Rubus roseus (?)

Popenoe, W. The tree dahlia of Guatemala. Jour. Hered. **11**: 265–268. *f. 20–22.* 5 F 1921.
Dahlia maxoni Safford.

Praeger, W. E. A collection of *Sphagnum* from the Douglas Lake region, Cheboygan County, Michigan. Ann. Rep. Michigan Acad. Sci. **21**: 237, 238. Jl 1920.

Reed, H. S. Volney Morgan Spalding. Plant World **22**: 14–18. Ja 1919.
With portrait.

Reyes, L. J. Fiber studies of Philippine dipterocarps. Jour. For. **19**: 97–104. F 1921.

Roberts, J. W. *Clitocybe sudorifica* as a poisonous mushroom. Mycologia **13**: 42–44. 3 F 1921.

Roberts, J. W. Stockton Mosby McMurran. Phytopathology **11**: 25, 26. Ja 1921.
With portrait.

Robinson, B. L. The Eupatoriums of Bolivia. Contrib. Gray Herb. II. **71**: 30–80. 30 D 1920.

Robinson, B. L. Further diagnoses and notes on tropical American Eupatorieae. Contrib. Gray Herb. II. **71**: 3–30. 30 D 1920.
Includes new species in *Ageratum* (1), *Alomia* (1), *Eupatorium* (9), and *Mikania* (19).

Rose, J. N. Botanical explorations in Ecuador. Bull. Pan-American Union **1921**: 24–34. Ja 1921.

Savelli, R. Virescente e proliferazioni in *Nicotiana Tabacum* e *N. sylvestris* Speg. Boll. Tecn. Tabacco **17**: 247–259. *pl. 1.* 1920.

Schertz, F. M. A chemical and physiological study of mottling of leaves. Bot. Gaz. **71**: 81–130. *f. 1–6.* 15 F 1921.
Coleus Blumei studied.

Scott, W. R. M., & Petry, E. N. Correlation of variation in resin content of *Podophyllum* with certain habitats. Ann. Rep. Michigan Acad. Sci. **21**: 225–231. Jl 1920.

Shear, C. L. Cranberry diseases and their control. U. S. Dept. Agr. Farmers' Bull. 1081: 1–22. *f. 1–12.* D 1920.

Sherff, E. E. Studies in the genus *Bidens*—V. Bot. Gaz. **70**: 89–109. *pl. 11–14.* 21 Au 1920.
Includes 13 new species from America and the Hawaiian Islands.

Shive, J. W. The influence of the moisture content of sand cultures upon the physiological salt balance for plants. New Jersey Agr. Exp. Sta. Ann. Rep. **40**: 358–363. 1920.

Shive, J. W. The influence of sand of different degrees of fineness upon the concentration and reaction of a nutrient solution. New Jersey Agr. Exp. Sta. Ann. Rep. **40**: 363–366. 1920.

Shunk, I. V., & Wolf, F. A. Further studies on bacterial blight of soybean. Phytopathology **11**: 18–24. *f. 1.* Ja 1921.

Smith, C. P. Studies in the genus *Lupinus*—V. The *Sparsiflori*. Bull. Torrey Club **47**: 487–509. *f. 53–66.* 24 N 1920.
Includes 6 new varieties.

Smith, G. M. Phytoplankton of the inland lakes of Wisconsin—I. Wisconsin Geol. & Nat. Hist. Surv. Bull. 57: 1–243. *pl. 1–51.* 1920.
Includes *Echinosphaerella* gen. nov. and new species in *Aphanocapsa* (1), *Rhizochrysis* (1), *Chlamydomonas* (2), *Volvox* (1), *Westella* (1), *Tetraedon* (1), *Selenastrum* (1), *Crucigenia* (1).

Standley, P. C. Ferns of Glacier National Park, Montana. Am. Fern Jour. **10**: 97–110. 7 F 1920.

Steinberg, R. A. Effect of zinc and iron compared with that of uranium and cobalt in growth of *Aspergillus*. Bot. Gaz. **70**: 465–468. 30 D 1920.

Stevens, F. L. New or noteworthy Porto Rican fungi. Bot. Gaz. **70**: 399–402. *f. 1–4.* 24 N 1920.

Stevens, N. E. The botany of the New England poets. Sci. Mo. **12**: 137–149. F 1921.

Stevenson, J. J. Interrelations of the fossil fuels. Proc. Am. Phil. Soc. **59**: 405–511. 20 D 1920.

Stewart, G. R., & Martin, J. C. Effect of various crops upon the water extract of a typical silty clay loam soil. Jour. Ag. Research **20**: 663–667. *f. 1–5.* 15 Ja 1921.

Stomps, T. J. Über die verschiedenen Zustande der Pangene. Biol. Zentralbl. **37**: 161–177. 30 Ap 1917.

[Corrected reprint.]

Stone, H. Les bois utiles de la Guyane Française—II. Ann. Mus. Colon. Marseille **26²**: 1–68. 1918.

Stone, R. E. Deadly poisonous mushrooms. Can. Field Natur. **34**: 74–78. *f. 1–4.* Ap 1920.

Stork, H. E. Biology, morphology, and cytoplasmic structure of *Aleurodiscus*. Am. Jour. Bot. **7**: 445–457. *pl. 31–33.* 12 Ja 1921.

Stout, A. B. A graft-chimera in the apple. Jour. Hered. **11**: 233–237. *f. 28.* 20 Ja 1921.

Stuckey, H. P. Work with *Vitis rotundifolia*, a species of Muscadine grapes. Georgia Exp. Sta. Bull. 133: 62–74. *f. 1–6.* 1920.

Sturtevant, E. L. Notes on edible plants. New York Agr. Exp. Sta. **1919**: 1–686. 1919. Edited by U. P. Hedrick. Forms part of N. Y. Agr. Exp. Sta. Report 1919 and vol. 2, part 2, of 27th annual report of N. Y. Depart. Agr.

Contains a brief biography of Sturtevant.

Sturtevant, G. Notes from my hybridization records. Am. Iris Soc. 2: 29, 30. Ja 1921.

Lists fertile and sterile varieties of *Iris*.

Svenson, H. K. A northeastern variety of *Panicum*. Rhodora **22**: 153–155. *f. 1–5.* 29 O 1920.

Panicum dichotomiflorum var. *puritanorum*, var. nov.

Swingle, W. T. A new species of *Pistacia* native to southwestern Texas, *P. texana*. Jour. Arnold Arbor. **2**: 105–110. 1920.

Tanaka, T. New Japanese fungi. Notes and translations—IX. Mycologia **12**: 329–333. 27 D 1920.

Taubenhaus, J. J. Wilts of the watermelon and related crops (*Fusarium* wilts of cucurbits.) Texas Agr. Exp. Sta. Bull. 260: 3–50. *f. 1–16*. F 1920.

Taylor, A. M. Appearance of mosses in ecological habitats. Bryologist **23**: 81–84. 8 F 1921.

Taylor, N. Effects of the winter of 1919–1920 on the woody plants in the Garden. Brooklyn Bot. Gard. Record **9**: 121–123. 1920.

Taylor, R. H. Report of the Assistant to the Chief of Division of Plant Industry. Bull. California Dept. Agr. **9**: 411–415. 1920.

Contains notes on the occurrence and spread of various weeds.

Teschauer, C. Algumas notas sobre ethnologia e "folklore" na flora e avifauna do Brasil. Arch. Mus. Nac. Rio Janeiro **22**: 221–230. 1919.

Thomas, H. E. The relation of the health of the host and other factors to infection of *Apium graveolens* by *Septoria Apii*. Bull. Torrey Club **49**: 1–29. 24 Ja 1921.

Tillotson, C. R. Growing and planting hardwood seedlings on the farm. U. S. Dept. Agr. Farmers' Bull. 1123: 1–29. *f. 1–15*. Ja 1921.

Tottingham, W. E., Roberts, R. H., & Lepkovsky, S. Hemicellulose of apple wood. Jour. Biol. Chem. **45**: 407–414. *f. 1*. F 1921.

Trelease, S. F. The growth of rice as related to proportions of fertilizer salts added to soil cultures. Philipp. Jour. Sci. **16**: 603–627. *f. 1–5*. Je 1920.

Tubeuf, C. V. Überblick über die Arten der Gattung *Arceuthobium* (*Razoumowskia*) mit besonderer Berücksichtigung ihrer Biologie und praktischen Bedeutung. Naturw. Zeitschr. Forst. und Landw. **1919**: 167–273. 1919.

Tuttle, F. M. Flora of Mitchell County [Iowa]. Proc. Iowa Acad. Sci. **26**: 269–299. *f. 92–95*. 1919.

Tuttle, G. M. Reserve food materials in vegetative tissues. Bot. Gaz. **71**: 145–151. 15 F 1921.

Van Alstine, E. The relation of salt proportions to the growth of wheat in sand cultures. New Jersey Agr. Exp. Sta. Ann. Rep. **40**: 366–374. *f. 1, 2*. 1920.

Victorin, Fr. Random botanical notes—III. Isle-aux-Coudres, Quebec. Can. Field Natur. **34**: 114–117. D 1919.

Viehover, A., Clevenger, J. F., & Ewing, C. O. Studies in mustard seeds and substitutes: I. Chinese colza, *Brassica campestris chinoleifera* Viehover. Jour. Agr. Research **20**: 117–140. *pl. 10–19.* 15 O 1920.

Visher, S. S. Geography of South Dakota. Univ. South Dakota Bull. 8: 7–189.

Contains chapter on biogeography.

Ward, H. A. A new station for *Gaylussacia brachycera.* Rhodora **22**: 167, 168. 7 D 1920.

Waksman, S. A. Studies in the metabolism of Actinomycetes—III. Nitrogen metabolism. Jour. Bact. **5**: 1–30. Ja 1920.

Waksman, S. A., & Joffe, J. S. Studies in the metabolism of Actinomycetes. IV. Changes in reaction as a result of the growth of Actinomycetes upon culture media. Jour. Bact. **5**: 31–48. Ja 1920.

Warming, E. Caryophyllaceae. Meddel. Grönland **37**: 231–342. *f. 1–44.* 1920.

Warner, M. F. The dates of Rheede's "Hortus Malabaricus." Jour. Bot. **48**: 291, 292. D 1920.

Waters, C. E. The Society for the Prevention of the Wild. Am. Fern Jour. **10**: 115–119. 7 F 1921.

Watson, E. E. On the occurrence of root-hairs on old roots of *Helianthus rigidus.* Ann. Rep. Michigan Acad. Sci. **21**: 235. Jl 1920.

Weatherby, C. A. What the Latin names mean—I. Am. Fern Jour. **10**: 113–115. 7 F 1921.

Welton, F. A. Longevity of seeds. Bull. Ohio Agr. Exp. Sta. 6: 18–24. 1921. [Illust.]

West, A. P., & Brown, W. H. Philippine resins, gums, seed oils, and essential oils. Philipp. Bur. For. Bull. 20: 1–230. *f. 1–73.* 1920.

West, F. L., & Edlefsen, N. E. Freezing of fruit buds. Jour. Agr. Research **20**: 655–662. 15 Ja 1921.

Wester, P. J. The cultivation and uses of roselle [*Hibiscus sabadariffa* L.]. Philipp. Agr. Rev. **13**: 89–99. *pl. 8–12.* 1920.

Wherry, E. T. *Asplenium Gravesii* in Pennsylvania. Am. Fern Jour. **10**: 119–121. 7 F 1921.

Wherry, E. T. The soil reactions of certain rock ferns. Am. Fern Jour. **10**: 15–22; 45–52. 1920.

Whetzel, H. H., & Humphrey, H. B. Frederick Kalpin Ravn. Phytopathology **11**: 1–5. Ja 1921.

Wiegand, K. M. Additional notes on *Amelanchier*. Rhodora **22**: 146–151. 29 O 1920.

2 new species and 1 new combination.

Wieland, G. R. Recedent lake shores of the Cretaceous. Science II. **52**: 537, 538. 3 D 1920.

Wilson, E. H. The romance of our trees—VI. The magnolias; VII. The beeches; VIII. The nut-bearers of the north; IX. Whence came our common fruits? X. The Lombardy poplar and the Babylon willow. XI. Trees of columnar growth. Gard. Mag. **31**: 48–53; 115–119; 194–198; 259–263; 317–320; 381–384. 1920. [Illust.]

Winslow, C.-E. A., and others. The families and genera of the Bacteria. Jour. Bact. **5**: 191–229. My 1920.

Wister, J. C. Notes on the history of the bearded iris. Jour. New York Bot. Gard. **21**: 181–191. O 1920.

Wolden, B. O. The moss and lichen flora of western Emmet County [Iowa]. Proc. Iowa Acad. Sci. **26**: 259–267. 1919.

Woodcock, E. F. Observations on the potato disease conditions in Michigan for the summer of 1918. Ann. Rep. Michigan Acad. Sci. **21**: 281–285. Jl 1920.

Woodward, R. W. *Panicum albemarlense* in Connecticut. Rhodora **22**: 182, 183. 14 Ja 1921.

Wright, R. C. An apparatus for determining small amounts of carbon dioxide. Am. Jour. Bot. **7**: 368–370 *f. 1*. 7 D 1920.

Wyant, Z. N. The influence of various chemical and physical agencies upon *Bacillus botulinus* and its spores. Jour. Bact. **5**: 553–557. N 1920.

Young, L. J. A study in the difference in soil requirements of pine and spruce. Ann. Rep. Michigan Acad. Sci. **21**: 219–221. Jl 1920.

Youngken, H. W., & Slothower, G. A. *Rhus venenata* DC. Am. Jour. Pharm. **92**: 695–701. O 1920.

Zeller, S. M. Wood decay in orchard trees in Oregon. Oregon Crop Pest and Hort. Rep. **3**: 132–138. *f. 35–37*. 10 Ja 1921.

Zinn, J. Wheat investigations. Pure lines. Maine Agr. Exp. Sta. Bull. 285: 1–48. *pl. 1–3*. Mr 1920.

Zon, R. Forests and human progress. Geog. Rev. **9**: 139–166. S 1920.

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BULLETIN

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A rearrangement of the Bolivian species of Centropogon and Siphocampylus

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Of forty species enumerated in the following article, six have been known to science for from fifty to ninety years, while thirty-four bear names not over thirty years old. Modern investigation of the two genera begins with Zahlbruckner, who in 1891* described three new species from the collections of Mandon. In 1892 Britton published in his enumeration† of the South American plants collected by Rusby a list of fifteen species and two varieties of these genera, of which eight species and both varieties were described as new. This was followed in 1896 by Rusby's paper‡ on the Bolivian collections of Miguel Bang, in which four species were mentioned, including three described as new. Zahlbruckner in 1897§ monographed the Lobeliaceae of Bolivia and recognized nine species of *Centropogon*, of which two were published as new, and twenty species and three varieties of *Siphocampylus*, of which eight species and the three varieties were regarded as new, making a total of thirty-four. Rusby listed‖ several species of both genera and described one as new in 1907, and in 1912 described**

* Ann. K. K. Naturhist. Hofmus. Wien **6**: 432–444. 1891.

† Bull. Torrey Club **19**: 371–374. 1892.

‡ Mem. Torrey Club **6**: 72–74. 1896.

§ Bull. Torrey Club **24**: 371–385. 1897.

‖ Bull. N. Y. Bot. Gard. **4**: 400–404. 1907.

** Bull. N. Y. Bot. Gard. **8**: 121–123. 1912.

[The Bulletin for June (**48**: 159–188) was issued August 1, 1921.]

three new species of *Siphocampylus* and one of *Centropogon* from the collections of Williams. Lauterbach published* a single variety in 1910, and in 1913 Zahlbruckner added three species† from the collections of Herzog.

Not all of these various species and varieties still stand just as they were published, but it is worthy of note that the studies in which they appeared were so exhaustive of the material at hand and subsequent collections have been so scanty that the present paper adds but one new species, although a second, recognized by Zahlbruckner and given a manuscript name by him, is here published. It is nevertheless fair to assume that more extended collection in Bolivia will bring to light probably a score or more new species.

Zahlbruckner's work was based largely on the same material as that used by Britton and Rusby, with additional specimens from certain European herbaria. The types of Britton's and of Rusby's species, and either the types or isotypes of most of Zahlbruckner's species, are in the collections at the New York Botanical Garden.

The four cited articles by Britton and Rusby include mere enumerations of the species with detached descriptions of their new species and varieties. Zahlbruckner gives in his monograph somewhat more detailed descriptions of the new species and frequent notes on the supposed affiliation of the others, and prefaces each genus with a key to the species included. His keys, however, are in general based on minor characters. While obviously related species are in most cases keyed out together, the characters used in distinguishing them are not of fundamental importance, give little idea of the relationship of the species, and can not be successfully used for the species of other South American countries.

Centropogon and *Siphocampylus* present the usual lobeliaceous structure. The leaves are almost always alternate, usually ample in size, and with a wide variation in shape, texture, and pubescence. The inflorescence is in a strict sense a terminal raceme, which by shortening of the internodes and suppression of the bracteal leaves becomes a terminal corymbose or subumbellate cluster, or by

* Buchtien, Contr. Flora Bolivia 1: 187. 1910.

† Med. Rijks Herb. 19: 49–53. 1913.

elongation of the internodes and better development of the subtending leaves is reduced to a series of solitary axillary flowers. The hypanthium, varying from depressed hemispheric to cylindric, bears five sepals, ranging from a size approximating the length of the corolla-tube to almost suppressed. The large corolla is usually brightly colored, with five equal or unequal, long or short, spreading, erect, or depressed lobes. The filaments usually surpass the corolla, and the anther-tube is frequently hirsute; in almost all species the two anterior anthers bear an appendage or tuft of hairs at the apex. The foliage is in some cases glabrous, but in most species is pubescent to tomentose with simple, branched or stellate hairs.

The distinctions between *Centropogon* and *Siphocampylus* are difficult and in herbarium material frequently obscure or lacking; as a result, sheets of what is obviously one species have been classified by Zahlbruckner himself in both genera. In *Centropogon* the fruit is a dry or leathery indehiscent berry. This flattens out in pressing and is thin enough to show the impression of the small seeds within. In *Siphocampylus* the fruit is a stiff, firm-walled capsule, but in many or even most herbarium sheets available mature fruit is not at hand. In the former genus, also, the summit of the ovary is described as truncate, that is, as almost completely adnate to the hypanthium, while in the latter it is stated to be conical, with a free distal portion, and adnate to the hypanthium only at its base. This condition does obtain in the ripened fruit, but can not always be demonstrated in flower. Between the baccate and the capsular species there is extensive parallelism; so extensive that a doubt may legitimately arise whether the characters of the fruit are really of generic value.

Because of this parallelism, the species of the two genera have not been kept separate in this paper but have been keyed out side by side, using the shape of the corolla as the primary distinction between groups. Three such groups have been distinguished, of which one includes only species of *Centropogon* (in the usual sense), the second only species of *Siphocampylus*, and the third species of both genera. To obviate the necessity of descriptions, the analytical key has been made more detailed than necessary for the mere separation of the species.

In both genera, the species show unusually clear lines of demarcation, and are separated by characters of the hypanthium, corolla, anther-tube, inflorescence, foliage, and pubescence. But since these characters show little correlated variation, the delimitation of species-groups and the determination of intrageneric relations become a matter of some difficulty, which is increased rather than lessened by extending the study to other South American countries.

Both genera find their center of distribution with the greatest number of species in the Andean region of northwestern South America from Colombia to Bolivia. Other South American and all North American forms are to be referred to this center for their geographical origin.

CONSPECTUS OF THE SPECIES

I. Corolla relatively short and broad, but large, the tube equaling or little exceeding the lobes, thick and firm in texture, white, yellowish, ochroleucous, or dull purple; corolla-lobes all depressed, the upper somewhat exceeding the lower; sepals ample, equaling or longer than the hypanthium; flowers solitary, on long axillary peduncles.

A. Hypanthium turbinate, broader than high when pressed, prominently ribbed anther-tube glabrous, or pubescent only on the connectives; corollas white or cinereous, the lobes equaling or exceeding the tube in length; fruit capsular, so far as known.

1. Anther-tube glabrous, except the terminal brush.

a. Sepals triangular-subulate, 4 mm. long, much shorter than the hypanthium.

1. SIPHOCAMPYLUS TUNARENSIS A. Zahlb. Bull. Torrey Club 24: 376. 1897.

The specimen in the herbarium of the New York Botanical Garden is fragmentary and does not permit the verification of Zahlbruckner's detailed description, but is sufficient to demonstrate its close relation to the following three species. Fruit has not been seen.

b. Sepals linear, equaling or exceeding the hypanthium in length.

2. SIPHOCAMPYLUS RUSBYANUS Britton, Bull. Torrey Club 19: 372. 1892.

Sepals 10 mm. long by 2 mm. wide; leaf-blades ovate-elliptic, 5–9 cm. long, acute or obtuse, rugose above, reticulate beneath, abruptly narrowed into a petiole 10–15 mm. long.

3. SIPHOCAMPYLUS VATKEANUS A. Zahlb. Bull. Torrey Club 24: 377. 1897.

Sepals little exceeding the hypanthium; leaf-blades oblong-lanceolate, 6–10 cm. long, 2–3 cm. wide, acuminate, tomentose on the reticulate veins beneath, obtuse or rounded at base, on petioles 1–2 cm. long.

2. Anther-tube white-woolly.

4. SIPHOCAMPYLUS RADIATUS Rusby, Mem. Torrey Club 6: 73. 1896.

Sepals 20–25 mm. long, 3–4 mm. wide, somewhat dilated below; leaf-blades lanceolate, 15–25 cm. long, acuminate, flat above, not conspicuously reticulate, gradually narrowed below to an indefinite petiole or sessile base.

4*a*. SIPHOCAMPYLUS RADIATUS MINOR A. Zahlb. Bull. Torrey Club 24: 376. 1897.

Plant smaller in all its parts; pedicels surpassing the leaves.

B. Hypanthium short-cylindric, higher than broad when pressed, or depressed-hemispheric; corolla-lobes usually shorter than the tube; anther-tube densely woolly; fruit baccate, so far as known.

1. Sepals linear or narrowly lanceolate, four to ten times as long as broad, longer than the short-cylindric hypanthium, equaling or exceeding the corolla-tube, with rounded sinuses nearly or quite as broad as the sepals; leaf-blades large, elliptic, 15–25 cm. long.

5. CENTROPOGON INCANUS (Britton) A. Zahlb. Bull. Torrey Club 24: 374. 1897.

Siphocampylus incanus Britton, Bull. Torrey Club 19: 373. 1892.

Petals and sepals densely floccose with yellowish gray hairs; filaments little exserted, the anther-tube barely surpassing the corolla; leaf-blades 5–10 cm. long, abruptly acuminate, floccose below and somewhat so above.

6. CENTROPOGON BRITTONIANUS A. Zahlb. Bull. Torrey Club 24: 373. 1897.

Siphocampylus giganteus latifolius Britton, Bull. Torrey Club 19: 373. 1892.

Petals and sepals thinly pubescent; filaments long (2 cm. or more)-exserted; leaf-blades 4–7 cm. broad, gradually acuminate, thinly tomentose on the veins beneath, puberulent above.

6*a*. CENTROPOGON BRITTONIANUS BREVIDENTATUS Zahlb. & Rechinger, Med. Rijks Herb. **19**: 51. 1913.

The authors state that the variety differs from the species in sepals only 10–12 mm. long and in much narrower and longer corolla-lobes.

2. Sepals broadly ovate to oblong, less than four times as long as wide, mostly shorter than the corolla-tube and not much exceeding the hypanthium, with narrow acute sinuses; hypanthium depressed-hemispheric or somewhat urceolate.

a. Sepals broadly ovate-triangular, herbaceous.

7. **Siphocampylus tunicatus** A. Zahlb. in herb.

Hypanthium and foliage nearly glabrous; leaf-blades broadly elliptic to obovate, 20–25 cm. long, 7–13 cm. wide, thin, abruptly acuminate; additional characters as in the key.

TYPE collected April, 1892, in Bolivia, at an altitude of 3000 m., by Otto Kuntze, and deposited in the herbarium of the New York Botanical Garden. A second sheet from the same collector comes from Santa Rosa, Bolivia, and is possibly a part of the same collection. The fruit is unknown but the floral characters show unmistakably the close relation of the species to the two following, *Centropogon Mandonis* and *C. gloriosus*, and it is quite probable that it will eventually be transferred to the genus *Centropogon*.

b. Sepals oblong or oblong-ovate, thick and firm, serrulate.

8. CENTROPOGON MANDONIS A. Zahlb. Ann. K. K. Naturhist. Hofmus. Wien **6**: 438. 1891.

Corolla-tube about twice as long as the erect, narrowly oblong sepals; filaments much surpassing the corolla; anther-tube hirsute with tawny hairs; leaves acute.

9. CENTROPOGON GLORIOSUS (Britton) A. Zahlb. Bull. Torrey Club **24**: 373. 1897.

Siphocampylus gloriosus Britton, Bull. Torrey Club **19**: 373. 1892.

Corolla-tube one third to one half longer than the oblong-ovate, frequently spreading or reflexed sepals; filaments about equaling the corolla; anther-tube hirsute with purple hairs; leaves long-acuminate.

II. Corolla tubular, slender, straight or somewhat curved, usually constricted above its base, little if any wider at the throat than at the base: corolla-lobes linear or linear-deltoid and regularly tapering from base to apex, all erect or slightly spreading, the lateral and ventral fissures usually progressively deeper than the dorsal; filaments equaling or barely exceeding the dorsal petals; the two ventral anthers with a terminal brush of separate hairs; fruit capsular, so far as known.

A. Hypanthium well developed and the ovary consequently mainly inferior.

1. Flowers in leafy corymbs, leafy racemes, or solitary in the axils of normal foliage leaves.

a. Anther-tube glabrous, except for the terminal brush, or with a few scattered hairs only.

i. Flowers axillary, subtended by normal foliage leaves.

* Sepals linear, exceeding the hypanthium; leaves much longer than wide.

† Peduncles well developed, equaling or surpassing the flowers, which exceed the subtending leaves.

‡ Leaves in whorls of three.

10. SIPHOCAMPYLUS ORBIGNIANUS A. DC.; DeCandolle, Prodr. 7: 405. 1839.

Siphocampylus volubilis Britton, Bull. Torrey Club 19: 372. 1892.

Leaf-blades ovate to ovate-oblong, sharply and irregularly dentate; sepals filiform, much exceeding the hypanthium; corolla scarlet.

The wealth of herbarium material indicates that this is the commonest Bolivian species of the two genera. It is distinguished at once by its verticillate leaves.

‡‡ Leaves alternate, oblong or elliptic to linear.

§ Corolla yellow or yellowish; leaf-blades linear to narrowly lanceolate, subentire, undulate, or with minute spinulose teeth.

11. SIPHOCAMPYLUS KUNTZEANUS A. Zahlb. Bull. Torrey Club 24: 378. 1897.

Anther-tube surpassing the corolla; leaves neatly linear, crowded, conduplicate.

12. SIPHOCAMPYLUS AUREUS Rusby, Mem. Torrey Club 6: 72. 1896.

Siphocampylus aureus latior A. Zahlb. Bull. Torrey Club 24: 378. 1897.

Anther-tube not exserted; leaves linear-lanceolate, membranous, flat.

§§ Corolla red.

|| Leaf-blades narrowly oblong-linear, narrowed below to an indefinite petiole, thick, remotely denticulate.

13. SIPHOCAMPYLUS WILLIAMSII Rusby, Bull. N. Y. Bot. Gard. **8**: 122. 1912.

|| || Leaf-blades lanceolate to ovate-lanceolate, petioled, membranous, sharply and irregularly spinulose, 8–12 cm. long.

14. SIPHOCAMPYLUS BOLIVIENSIS A. Zahlb. Ann. K. K. Naturhist. Hofmus. Wien **6**: 443. 1891.

Sepals equaling or barely exceeding the subglobose hypanthium; stems stout; leaves firm, brownish and scabrously pubescent beneath.

15. SIPHOCAMPYLUS DUBIUS A. Zahlb. Bull. Torrey Club **24**: 385. 1897.

Sepals longer than the depressed-hemispheric hypanthium; stems slender; leaves thin, green and puberulent on the veins beneath.

†† Peduncles short, equaling or shorter than the flowers, which do not surpass the subtending leaves; hypanthium turbinate; sepals linear, reflexed; leaf-blades oblong, short-petioled; stems climbing.

16. SIPHOCAMPYLUS MEMBRANACEUS Britton, Bull. Torrey Club **19**: 372. 1892.

Leaves thin, membranous, sharply spinulose-dentate, veiny; peduncles equaling the corolla.

17. SIPHOCAMPYLUS OBLONGIFOLIUS Rusby, Mem. Torrey Club **6**: 73. 1896.

Leaves firm, minutely and remotely spinulose; peduncles shorter than the corolla.

** Sepals narrowly triangular, shorter than the hypanthium.

18. SIPHOCAMPYLUS CORREOIDES A. Zahlb. Bull. Torrey Club **24**: 382. 1897.

Foliage and flowers tomentulose; leaf-blades broadly ovate, undulate and spinulose-denticulate, 15–25 mm. long.

ii. Flowers in terminal corymbs or much abbreviated racemes; hypanthium turbinate or somewhat urceolate; sepals about equaling the hypanthium, distant, with rounded sinuses; leaf-blades sharply and saliently serrate, of an ovate type, firm, dull-green.

19. SIPHOCAMPYLUS CORYMBIFERUS Pohl. Plant. Brasil. **2**: 112. *pl. 175*. 1831.

Lobelia corymbifera Presl, Prodr. Monogr. Lobel. 37. 1836.

Siphocampylus gracilis glabris Britton, Bull. Torrey Club **19**: 374. 1892.

Leaves glabrous.

20. SIPHOCAMPYLUS GRACILIS Britton, Bull. Torrey Club **19**: 374. 1892.

Siphocamplyus corymbiferus gracilis A. Zahlb. Bull. Torrey Club **24**: 384. 1897.

Leaves softly pubescent.

iii. **Flowers in crowded leafy racemes.**

21. SIPHOCAMPYLOS TUPAEFORMIS A. Zahlb. Ann. K. K. Naturhist. Hofmus. Wien **6**: 440. 1891.

Hypanthium hemispheric or somewhat urceolate, ribless or faintly nerved; flowers 40–45 mm. long, approximately equaling the ascending, straight or gently curved pedicels; leaves softly pubescent beneath.

b. Anther-tube conspicuously woolly in five strongly marked lines; leaf-blades lanceolate or broader, rounded at base; sepals much longer than the hypanthium, which is strongly ribbed at maturity.

* Leaf-blades long-acuminate, ovate-lanceolate to lance-oblong, sharply and irregularly spinulose-denticulate.

22. SIPHOCAMPYLUS ARGUTUS A. Zahlb. Bull. Torrey Club **24**: 383. 1897.

Leaf-blades thin, glabrous beneath, not prominently reticulate; petioles straight or curved.

23. SIPHOCAMPYLUS BILABIATUS A. Zahlb. Bull. Torrey Club **24**: 382. 1897.

Siphocampylus bilabiatus glabratus Lauterbach; Buchtien, Contr. Flora Bolivia **1**: 187. 1910.

Leaf-blades firm, pubescent beneath, prominently reticulate; petioles sigmoid.

** Leaf-blades ovate-oblong, 5–8 cm. long, broadly rounded or subcordate at base, obtuse or rounded at apex, minutely and remotely denticulate.

24. SIPHOCAMPYLUS SUBCORDATUS Rusby, Bull. N. Y. Bot. Gard. **8**: 121. 1912.

2. Flowers in terminal, leafless, bracted racemes; pedicels flexuous in anthesis, 1 cm long or less; hypanthium turbinate, strongly ribbed or subangulate, somewhat constricted at the throat, equaling or exceeding the relatively short sepals; calyx-sinuses broad.

a. Hypanthium glabrous; leaf-blades falcate, conduplicate.

25. SIPHOCAMPYLUS ANGUSTIFLORUS Schlecht.; Lechler, Pl. Lechler. Peruv. *2649*.

Specimens of this species have not been seen: the distinction between it and the following are taken from Zahlbruckner.

b. **Hypanthium pubescent; leaf-blades flat.**

26. SIPHOCAMPYLUS FLAGELLIFORMIS A. Zahlb. Bull. Torrey Club **24**: 380. 1897.

Siphocampylus angustiflorus Britton, Bull. Torrey Club **19**: 372. 1892; not *S. angustiflorus* Schlecht.

Leaf-blades lanceolate or narrowly elliptic-ovate, acuminate, 40–60 mm. long, 15–22 mm. wide, sharply serrulate, glabrous and conspicuously veiny beneath.

27. **Siphocampylus altiscandens** sp. nov.

Stems puberulent, climbing 40 feet high on trees; leaves rather crowded, the blades flat, firm in texture, ovate-oblong, acute or subacuminate, entire or remotely and minutely serrulate, almost glabrous above, minutely puberulent beneath, the larger ones 60–75 mm. long by 25–35 mm. wide; inflorescence secund, the pedicels 10 mm. long or less; flowers deflexed; hypanthium thinly pubescent, turbinate or obconic, 4 mm. high; sepals triangular, 1 mm. long, with recurved tips; corolla rose-color, 30–35 mm. long, its lobes linear, erect or spreading; filaments about equaling the petals; anthers glabrous below, all more or less hirsute at the tip.

TYPE, *Bang 2553*, collected at Uchimachi, Corvico, Bolivia, July 20, 1894, and deposited in the herbarium of Columbia University. His field notes state that it grows in damp forests and that only two plants were seen, from which forty specimens were collected. It is sharply distinguished from the preceding species by its leaf characters.

B. Hypanthium very small in proportion to the flower and the ovary mainly free; corolla scarlet, 6–7 cm. long; leaf-blades of a lanceolate or ovate type; sepals usually serrulate; stems climbing· anther-tube glabrous.

1. Sepals linear to linear-oblong, prominently reflexed; leaves sharply acuminate.

28. SIPHOCAMPYLUS ELEGANS Planch. Flore des Serres **6**: 19. 1850.

Leaf-blades thick and firm, elongate-lanceolate, rounded or truncate at base.

Siphocampylus elegans boliviensis A. Zahlb. Bull. Torrey Club **24**: 381. 1897.

The single specimen examined, *Mandon 498*, does not agree

perfectly with Planchon's figure and may prove specifically distinct.

29. SIPHOCAMPYLUS REFLEXUS Rusby, Bull N. Y. Bot. Gard. 4: 403. 1907.

Siphocampylus elegans cordatus A. Zahlb. Bull. Torrey Club 24: 381. 1897.

Leaf-blades thin, ovate-lanceolate, with a long narrow acumination, distinctly cordate at base.

2. Sepals ovate-oblong, erect or somewhat spreading; leaves acute to subacuminate.

30. SIPHOCAMPYLUS ANDINUS Britton, Bull. Torrey Club 19: 373. 1892.

III. Corolla tubular, stout, conspicuously ventrally curved, little or not at all constricted at base, distinctly ampliate toward the throat, corolla-lobes with broad bases, more or less oblique, and curved or directed anteriorly, the two upper usually distinctly larger and broader than the three lower, the lower fissures little if any deeper than the dorsal; fruit baccate, so far as known.

A. Ventral anthers terminating in a tuft of loose hairs, dorsal anthers sparsely pilose; hypanthium distinctly urceolate; foliage and flowers strongly tomentulose; petals all about equal, broadly and obliquely triangular, acute; filaments long-exserted; leaves petioled, the blades oblong-lanceolate, acute.

31. CENTROPOGON UNDUAVENSIS (Britton) A. Zahlb. Bull. Torrey Club 24: 374. 1897.

Siphocampylus unduavensis Britton, Bull Torrey Club 19: 373. 1892.

B. Ventral anthers terminating in a stiff scale composed of united hairs; hypanthium hemispheric to campanulate; foliage and flowers not tomentulose; at least the much smaller lower petals terminating in linear or subulate strongly curved appendages.

1. Sepals linear to triangular, with broad flat sinuses; leaf-blades narrowly to broadly oblong or obovate.

* Leaf-blades broadly oblong, almost entire.

32. CENTROPOGON YUNGASENSIS Britton, Bull. Torrey Club 19: 371. 1892.

Leaves firm, glabrous; sepals triangular, distinctly shorter than the hypanthium.

** Leaf-blades narrowly oblong denticulate or crenate.

33. **Centropogon aggregatus** (Rusby) comb. nov.

Siphocampylus aggregatus Rusby, Bull. N. Y. Bot. Gard. 8: 122. 1912.

Filaments tomentose toward the summit; anther-tube pubescent in lines; sepals equaling the hypanthium or a little shorter; leaves crenate.

34. CENTROPOGON SURINAMENSIS (L.) Presl, Prodr. Monogr. Lobel. 48. 1836.

Lobelia surinamensis L. Sp. Pl. ed. 2, 1320. 1763.

Filaments glabrous or with scattered hairs; anther-tube sparsely hirsute or glabrous; sepals serrate, distinctly exceeding the hypanthium: leaves denticulate.

2. Sepals linear-triangular to ovate, with narrow acute sinuses; leaf-blades oblong-lanceolate to lanceolate, usually sharply denticulate; flowers in terminal corymbose clusters.

* Sepals narrowly linear-triangular, entire, much longer than the hypanthium.

35. CENTROPOGON AMPLIFOLIUS Vatke, Linnaea **38**: 716. 1874.

** Sepals triangular-ovate to broadly ovate.

36. CENTROPOGON BANGII A. Zahlb. Bull. Torrey Club **24**: 372. 1897.

Sepals triangular-ovate, entire, shorter than the hypanthium.

37. CENTROPOGON ROSEUS Rusby, Bull. N. Y. Bot. Gard. **8**: 123. 1912.

Sepals broadly ovate, foliaceous, denticulate.

IV. Species of uncertain position, specimens of which have not been seen.

38. CENTROPOGON MAGNIFICUS Zahlb. & Rechinger, Med. Rijks Herb. **19**: 50. 1913.

Evidently a member of the first group of this conspectus; compared by the authors with *C. Mandonis* Zahlb., from which it differs in its fewer flowers on longer pedicels, straight-edged sepals, denser pubescence on the corolla, obviously lignified twigs, and stiffer rough leaves.

39. CENTROPOGON HERZOGI Zahlb. & Rechinger, Med. Rijks Herb. **19**: 49. 1913.

Evidently a member of the second section of this conspectus, as indicated by the description of the corolla; flowers axillary, hypanthium globose or subglobose, sepals short, acute, broadly triangular, anther-tube glabrous, except the terminal tuft.

40. CENTROPOGON CARDINALIS Zahlb. & Rechinger, Med. Rijks, Herb. **19**: 51. 1913.

Evidently a member of the third group of this conspectus, possibly related to *C. Bangii* Zahlb.; inflorescence a short terminal raceme, hypanthium globose, sepals short, triangular, entire, anther-tube glabrous, except the terminal appendage, leaves obovate-elliptic.

NEW YORK BOTANICAL GARDEN

Vegetative reproduction and aposporous growths from the young sporophyte of Polypodium irioides

W. N. Steil

(WITH THREE TEXT FIGURES)

From an old culture of the prothallia of *Polypodium irioides* Poir. made March 21, 1916, the largest gametophytes, including a number bearing sporophytes, were on several occasions removed for class use. In the autumn of 1918, when regeneration from the sporophyte was first observed, only three sporophytes remained in the culture.

The largest and most vigorous bore six leaves and by March 4, 1919, had produced nine leaves. The largest leaf of this sporophyte was about 5 cm. in length and 5 mm. in width. From one of the smaller leaves of the sporophyte regeneration occurred. This leaf was only 1 cm. in length and 3 mm. in width. There was a well-developed vein in the leaf and the epidermal cells, including the guard cells, were of the usual type. It was impossible to determine whether the leaf was the primary one, since the juvenile leaves of this fern resemble closely one another and also the leaves of the mature sporophyte. Three of the sporophytic growths produced by the leaf originated along the margin (FIG. 1, *b*, *c*, and *f*), one from the lower surface (*d*), and one from the upper surface (*c*).

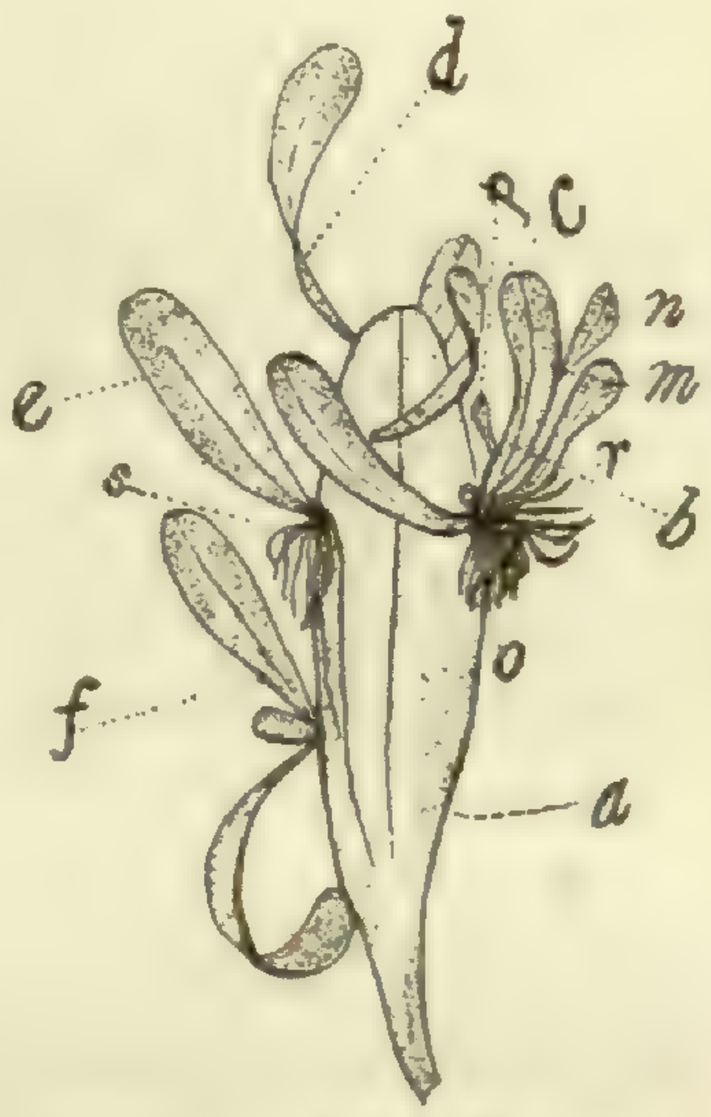

FIG. 1. A leaf of a young sporophyte of *Polypodium irioides*, which has produced secondary sporophytes and secondary leaves, x 3.

From two portions of the leaf were developed complete sporophytes, that is, sporophytes with both leaves and roots (FIG. 1, *b* and *c*). The other outgrowths consisted of one or more leaves, and one bore in addition to two leaves numerous rhizoid-like hairs from the point of origin of the leaves (*s*). These were extremely long,

and in respect to length resembled root hairs. None of the sporophytic outgrowths were connected with the vein of the leaf of the sporophyte.

By March 4, 1919, the parent leaf had increased little in size. At this time it was observed that a leaf (*m*) of one of the complete sporophytes (*b*) had regenerated and produced in turn three outgrowths (FIG. 1, *o*, *n*, and *p*), which later developed into leaves.

The two complete sporophytes were detached and planted on *Sphagnum*. From one of the sporophytes (*b*) a leaf (*n*) was removed and was likewise planted on *Sphagnum*. The two sporophytes lived only a short time. From the detached leaf (*n*) it was discovered, May 12, 1919, that four outgrowths had been produced. Three of these were gametophytic, and the other sporophytic. A portion of the leaf and two of the young prothallia (*m* and *n*) are represented in FIG. 2. One of the outgrowths produced a large cell (*a*), probably apical in nature. The three gametophytic or prothallial growths developed from the leaf of the sporophyte are aposporous. The cells of the leaf surrounding the gametophytic developments are somewhat intermediate between the two generations. The parent leaf soon showed signs of exhaustion and June 15, 1919, was partially dead. Later all of the outgrowths of the leaf died.

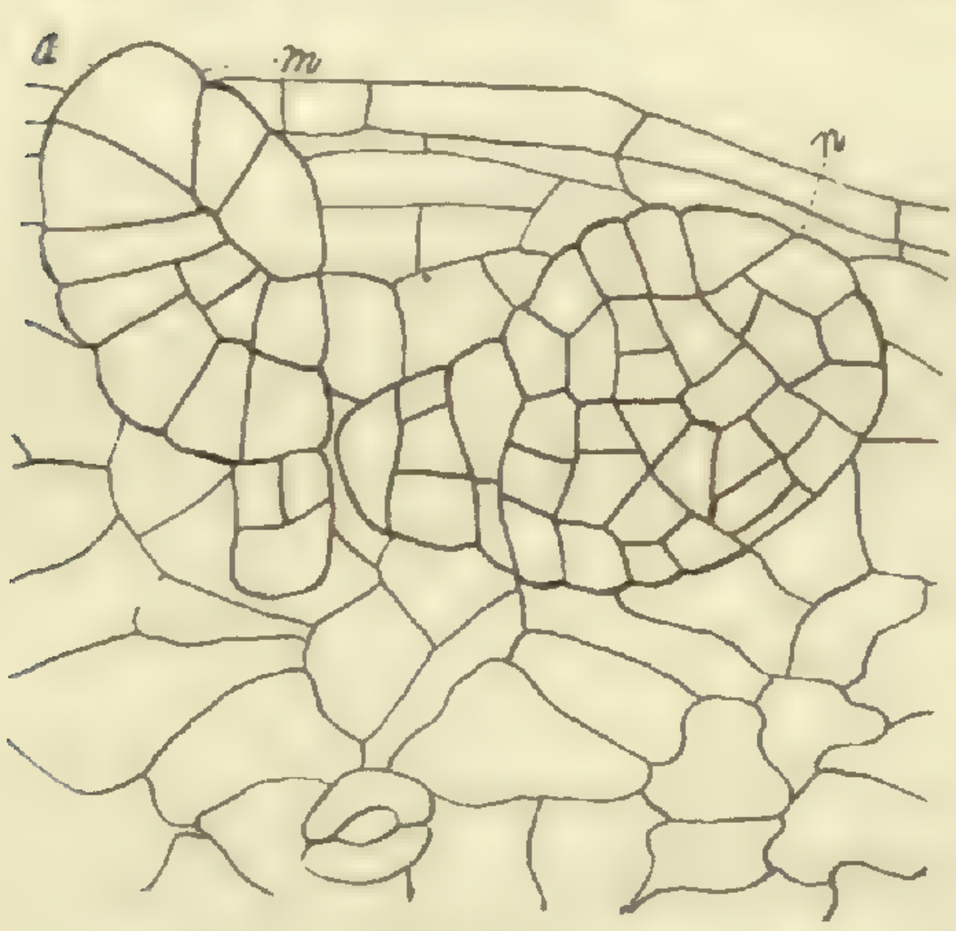

FIG. 2. Aposporously produced prothallia from a leaf of *Polypodium irioides*, x 200.

Another sporophyte in the culture produced from each of the leaves a normal leaf. Roots were not developed. Since the sporophyte bore three leaves, one of the regenerating leaves was a secondary one.

The remaining sporophyte bore four leaves, each of which developed one or more outgrowths. In one instance a leaf produced a cylindrical structure distinctly gametophytic in its cellular nature. It produced numerous rhizoids at its point of origin. This gametophytic outgrowth was also of aposporous origin. A normal leaf was formed by another of the four leaves. At the

base of the third leaf two small cellular masses appeared, probably sporophytic in nature. The fourth leaf produced a similar cellular mass, represented in section by FIG. 3. In no case were these cellular masses connected with the vascular system of the leaf. It is of interest to note in this case that all of the leaves of the sporophyte produced outgrowths.

FIG. 3. A section through a cellular mass produced from the leaf of *Polypodium irioides*, x 200.

The cultural conditions under which regeneration from the sporophyte and apospory occur in *Polypodium irioides* are not known to the writer. The phenomena appeared in an old culture in which the conditions may have been unfavorable for the normal development of the sporophyte. It may be added, however, that a fresh supply of a nutrient solution was on several occasions applied to the culture.

UNIVERSITY OF WISCONSIN

INDEX TO AMERICAN BOTANICAL LITERATURE

1917–1921

The aim of this Index is to include all current botanical literature written by Americans, published in America, or based upon American material; the word America being used in the broadest sense.

Reviews, and papers that relate exclusively to forestry, agriculture, horticulture, manufactured products of vegetable origin, or laboratory methods are not included, and no attempt is made to index the literature of bacteriology. An occasional exception is made in favor of some paper appearing in an American periodical which is devoted wholly to botany. Reprints are not mentioned unless they differ from the original in some important particular. If users of the Index will call the attention of the editor to errors or omissions, their kindness will be appreciated.

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Adams, J. F. Gametophytic development of blister rusts. Bot. Gaz. **71**: 131–137. *f. 1–4.* 15 F 1921.

Adams, J. F. Observations on the infection of *Crataegus* by *Gymnosporangium.* Mycologia **13**: 45–49. *f. 1–4.* 3 F 1921.

Allen, M. E. The supposed generic character of *Naumburgia.* Rhodora **22**: 193, 194. 15 F 1921. [Illust.]

Arthur, J. C. Aecidiaceae (cont.). N. Am. Fl. **7**: 405–480. 8 F 1921.

Includes collaboration by H. S. Jackson on *Dicaeoma* on Carduaceae and by C. R. Orton on *Allodus.*

Arthur, J. C. Nineteen years of culture work. Mycologia **13**: 12–23. 3 F 1921.

Artschwager, E. F. Pathological anatomy of potato blackleg. Jour. Agr. Research **20**: 325–330. *pl. 57, 58 + f. 1.* 15 N 1920.

Babcock, E. B., & Collins, J. L. Interspecific hybrids in *Crepis.* I. *Crepis capillaris* (L.) Wallr. × *C. tectorum* L. Proc. Nat. Acad. Sci. **6**: 670–673. 15 N 1920.

Bailey, I. W. The cambium and its derivative tissues. III. A reconnaissance of cytological phenomena in the cambium. Am. Jour. Bot. **7**: 417–434. *pl. 26–29.* 12 Ja 1921.

Barnhart, J. H. *Aetopteron* as a generic name. Am. Fern Jour. **10**: 7 F 111, 112. 7 F 1920.

Barss, H. P. Bean blight and bean mosaic. Oregon Crop Pest & Hort. Rep. **3**: 192–196. *f. 56–59.* 10 Ja 1921.

Barss, H. P. *Cylindrosporium* leaf-spot of prune and cherry. Oregon Crop Pest and Hort. Rep. **3**: 156–158. *f. 42, 43.* 10 Ja 1921.

Barss, H. P. Physiological disorders of developing fruits. Oregon Crop Pest & Hort. Rep. **3**: 159–166. *f. 44–47.* 10 Ja 1921.

Bartlett, H. H. The manufacture of sugar from *Arenga saccharifera* in Asahan, on the east coast of Sumatra. Ann. Rep. Michigan Acad. Sci. **21**: 155–165. *pl. 3–6.* Jl 1920.

Bessey, E. A. Guide to the literature for the identification of fungi—a preliminary outline for students and others. Ann. Rep. Michigan Acad. Sci. **21**: 287–316. Jl 1920.

Bessey, E. A. The effect of parasitism upon the parasite—a study in phylogeny. Ann. Rep. Michigan Acad. Sci. **21**: 317–320. Jl 1920.

Blake, S. F. Five new species of *Cedrela*. Proc. Biol. Soc. Washington **33**: 107–111. 30 D 1920.

Blake, S. F. Revision of *Ichthyomethia*, a genus of plants used for poisoning fish. Jour. Washington Acad. Sci. **9**: 241–252. 4 My 1919.

Includes 2 new species from Tropical America.

Blake, S. F. New trees and shrubs from Mexico and Guatemala. Proc. Biol. Soc. Washington **33**: 117–120. 30 D 1920.

Species of *Capparis* (1), *Jatropha* (1), *Guarea* (1), and *Russelia* (2).

Blake, S. F. Two new salvias from Guatemala. Proc. Biol. Soc. Washington **33**: 113–115. 30 D 1920.

Blakeslee, A. F. Mutation in mucors. Jour. Hered. **11**: 278–284. *f. 26–28.* 5 F 1921.

Bouyoucos, G. J., & McCool, M. M. Measurement of the amount of water that seeds cause to become unfree and their water-soluble material. Jour. Agr. Research **20**: 587–593. 3 Ja 1921.

Bradshaw, R. V. A new Oregon *Eucephalus*. Torreya **20**: 122, 123. 5 F 1921.

Eucephalus vialis sp. nov.

Brandegee, T. S. Plantae Mexicanae Purpusianae, X. Univ. California Publ. Bot. **7**: 325–331. 29 D 1920.

Includes *Pachystelma* gen.nov., and new species in 17 other genera.

Breazeale, J. F., & Briggs, L. J. Concentration of potassium in orthoclase solutions not a measure of its availability to wheat seedlings. Jour. Agr. Research **20**: 615–621. 15 Ja 1921.

Britton, N. L. William Harris. Jour. New York Bot. Gard. **22**: 13, 14. Ja 1921.

Brotherton, W. The heredity of "rogue" types in garden peas (*Pisum sativum*). Ann. Rep. Michigan Acad. Sci. **21**: 263–279. *pl. 7–13* + *f. 3*. Jl 1920.

Brush, W. D. Utilization of black walnut. U. S. Dept. Agr. Bull. 909: 1–89. *pl. 1–14* + *f. 1–7*. 17 Ja 1921.

Burnham, S. H. *Camptothecium nitens* var. *falcifolium* Ren. Bryologist **23**: 92. 8 F 1921.

Burnham, S. H. The mosses of the Lake George flora. Bryologist **23**: 38–45; 54–60. 1920.

Catoni, L. A. El cultivo de la vainilla en Puerto Rico. Revista Agric. Puerto Rico. **5**[6]: 11–23. 30 D 1920.

Chiovenda, E. L'*Eragrostis caroliniana* (Spreng.) Scribner. Boll. Soc. Bot. Italiana **1920**: 11–16. 1920.

Chodat, R., & Vischer, W. La végétation du Paraguay. VIII–X. Pp. 291–379. *f. 228–280*. Geneva. 1920.

Reprint, with altered pagination, from Bull. Soc. Bot. Genève II. **11**: 211–299. 1919.

Clarke, J. M. The oldest of the forests. Sci. Mo. **12**: 83–91. Ja 1921. [Illust.]

Clarkson, E. H. The story of a fern garden—I. Am. Fern Jour. **10**: 53–57; 82–87. 1920.

Clute, W. N. The power of movement in plants. Gard. Chron. Am. **25**: 426. Ja 1921.

Clute, W. N. Plant travelers. Gard. Chron. Am. **25**: 467, 468. F 1921.

Conzatti, C. El estado de Oaxaca y sus recursos naturales. Pp. 1–83. Oaxaca, Mexico. 1920.

Coons, G. H. The Michigan plant disease survey for 1918. Ann. Rep. Michigan Acad. Sci. **21**: 331–343. *pl. 15*. Jl 1920.

Darlington, H. T. Distribution of the Orchidaceae in Michigan. Ann. Rep. Michigan Acad. Sci. **21**: 239–261. Jl 1920. [Illust.]

Contains keys to species and lists of specimens seen.

Davis, A. R. The variability of plants grown in water cultures. Soil Sci. **11**: 1–32. Ja 1921.

Davis, C. B. Revelations in hairs. Guide Nat. **13**: 117–123. *f. 1–7*. Ja 1921.

Dawe, M. T. Account of a journey through the western portion of Colombia, showing the possibilities of the economic development of the districts visited. Pp. 1–27. *f. 1–18* + map. London. 1919.
Contains many notes of plants seen.

Detjen, L. R. The Herald—new type of prune. Jour. Hered. **11**: 253–258. *f. 11–15*. 5 F 1921.

Detjen, L. R. Peloria in *Viola primulaefolia* Linn. Torreya **20**: 107–116. *f. 1–10*. 5 F 1921.

Diehl, W. W. The fungi of the Wilkes Expedition. Mycologia **13**: 38–41. 3 F 1921.
Contains list of 31 species, with localities.

Earle, F. S. El mosaico de la caña o matizado. El estado actual de la epidermia. Puerto Rico Dept. Agric. y Trab. Circ. **22**: 1–9. Ap 1920.

Earle, F. S. Seleccion de la semilla de caña para siembra de gran cultura. Revista Agric. Puerto Rico **5**[6]: 7–10. 30 D 1920.

Edson, H. A. Vascular discoloration of Irish potato tubers. Jour. Agr. Research **20**: 277–294. 15 N 1920.

Ellen, Sister M. The germination of the spores of *Conocephalum conicum*. Am. Jour. Bot. **7**: 458–464. *pl. 34, 35*. 12 Ja 1921.

Farwell, O. A. Notes on the Michigan flora—II. Rep. Michigan Acad. Sci. **21**: 345–371. Jl 1920.
Contains new varieties, forms and combinations in many genera.

Fenno, F. E. Plants of the Susquehanna Valley and adjacent hills of Tioga County [New York], II. Supplementary list. New York State Mus. Bull. 219, 220: 247–250. 1920.

Fernald, M. L. Brainerd & Peitersen's blackberries of New England. Rhodora **22**: 185–191. 15 F 1921.
Review, but containing much original matter.

Fleming, C. E., & Peterson, N. F. The narrow-leaved milkweed (*Asclepias mexicana*) and the broad-leaved, or showy milkweed (*Asclepias speciosa*). Univ. Nevada Agr. Exp. Sta. Bull. 99: 1–32. *f. 1–10*. D 1920.
Plants poisonous to live stock in Nevada.

Friesner, R. C. Periodicity of elongation and cell division. Ann. Rep. Michigan Acad. Sci. **21**: 233, 234. Jl 1920.
Preliminary note.

Gerry, E. American storax production: results of different methods of tapping red gum trees. Jour. For. **19**: 15–24. *f. 1–4*. Ja 1921.
Discusses supply from *Liquidambar Styraciflua* L.

Gorman, M. V. Flora of Hamilton Mountain, Washington. Mazama **6**: 62–77. D 1920.

Hahn, G. G., Hartley, C., & Rhoades, A. S. Hypertrophied lenticels on the roots of conifers and their relation to moisture and aeration. Jour. Agr. Research **20**: 253–265. *pl. 44–46.* 15 N 1920.

Hansen, A. A. Dodder. U. S. Dept. Agr. Farmers' Bull. 1161: 1–21. *f. 1–10.* Ja 1921.

Harper, R. M. Water and mineral content of an epiphytic fern. Am. Fern Jour. **9**: 99–103. 24 Ja 1920.

Harris, J. A., & Scofield, C. S. Permanences in the plots of an experimental field. Jour. Agr. Research **20**: 335–356. 1 D 1920.

Harvey, L. H. Some phytogeographical observations in Lake County, Michigan. Am. Rep. Michigan Acad. Sci. **21**: 213–217. Jl 1920.

Hawkins, L. A., & Magness, J. R. Some changes in Florida grapefruit in storage. Jour. Agr. Research **20**: 357–373. 1 D 1920.

Hibbard, R. P., & Gershberg, S. The biological method of determining the fertilizer requirement of a particular soil or crop. Ann. Rep. Michigan Acad. Sci. **21**: 223, 224. Jl 1920.

Higgins, B. B. Morphology and life history of some Ascomycetes with special reference to the presence and function of spermatia. Am. Jour. Bot. **7**: 435–444. *pl. 30 + f. 1, 2.* 12 Ja 1921.

Holzinger, J. M. On our American form of *Timmia megapolitana* Hedw. Bryologist **23**: 86–88. *f. 1–5.* 8 F 1921.

With drawing by E. B. Chamberlain.

Homans, G. M. Forest distribution in California. Rep. State Forester California **7**: 58–85. 1919. [Illust.]

House, H. D. Notes on fungi, VI. New York State Mus. Bull. 219, 220: 233–246. *f. 1–3.* 1920.

Includes *Mycena Atkinsoni* sp. nov.

Howard, W. L., & Horne, W. T. Brown rot of apricots. California Agr. Exp. Sta. Bull. 326: 73–88. *f. 1–5.* Ja 1921.

Hurd, A. M. Injury to seed wheat resulting from drying after disinfection with formaldehyde. Jour. Agr. Research **20**: 209–244. *pl. 36–41.* 1 N 1920.

Illick, J. S. Replacement of the chestnut. Jour. For. **19**: 105–114. F 1921.

Jagger, I. C. *Sclerotinia minor* n. sp., the cause of a decay of lettuce, celery, and other crops. Jour. Agr. Research **20**: 331–333. *pl. 59 + f. 1.* 15 N 1920.

Jenkins, E. W. Cotton and some of its diseases and insects. Univ. Florida Agr. Extens. Bull. 15: 1–19. *f. 1–7.* F 1919.
[Corrected reprint.]

Jennings, O. E. Fossil plants from the beds of volcanic ash near Missoula, western Montana. Mem. Carnegie Mus. **8**: 385–450. *pl. 22–33* + *f. 1.* S 1920.
Includes new species in *Equisetum* (1), *Sequoia* (1), *Juglans* (1), *Betula* (1), *Alnus* (2), *Quercus* (1), *Ficus* (1), *Ilex* (1), *Celastrus* (1), *Aralia* (1), and *Vaccinium* (1).

Johnson, J. *Fusarium*-wilt of tobacco. Jour. Agr. Research **20**: 515–536. *pl. 63–67.* 3 Ja 1921.

Jones, F. R., & Drechsler, C. Crownwart of alfalfa caused by *Urophlyctis Alfalfae.* Jour. Agr. Research **20**: 295–323. *pl. 47–56.* 15 N 1920.

Jones, L. H., & Shive, J. W. The influence of iron in the forms of ferric phosphate and ferrous sulfate upon the growth of wheat in a nutrient solution. Soil Sci. **11**: 93–98. *pl. 1.* F 1921.

Jones, L. R., Walker, J. C., & Tisdale, W. B. *Fusarium* resistant cabbage. Agr. Exp. Sta. Univ. Wisconsin Research Bull. 48: 1–34. *f. 1–10.* N 1920.

Judd, C. S. Algaroba seed germination tests. Hawaiian For. & Agric. **17**: 342–344. D 1920.
Prosopis juliflora.

Jurica, H. S. Development of head and flower of *Dipsacus sylvestris.* Bot. Gaz. **71**: 138–145. *f. 1–14.* 15 F 1921.

Kaiser, G. B. Little journeys into mossland—I. Early bryological experiences. Bryologist **23**: 88–90. 8 F 1921.

Keitt, T. E., & Murray, A. W. The influence of certain factors on the time of opening of cotton. Georgia Exp. Sta. Bull. 130: 21–34. *f. 1–3.* 1920.

Kelley, W. P., & Cummins, A. B. Composition of normal and mottled *Citrus* leaves. Jour. Agr. Research **20**: 161–191. 1 N 1920.

Kimball, W. Reminiscences of Alvan Wentworth Chapman. Jour. New York Bot. Gard. **22**: 1–11. Ja 1921

Knowlton, C. H., & Deane, W. Reports on the flora of the Boston district, XXXIII. Rhodora **22**: 123–127. 3 Au 1920.

Koser, S. A. A bacteriological study of canned ripe olives. Jour. Agr. Research **20**: 375–379. 1 D 1920.

Kraemer, H. Michigan—an important source of raw vegetable products. Ann. Rep. Michigan Acad. Sci. **21**: 167–199. Jl 1920.
With especial account of medicinal properties of native plants.

Kraus, E. J. The modification of vegetative and reproductive functions under some varying conditions of metabolism. Am. Jour. Bot. **7**: 409–416. Ja 1921.

Krelage, E. H. The development of the tall bearded irises in the 19th century. Am. Iris Soc. No. 2: 3–14. Ja 1921.

Lee, H. A., & Serrano, F. B. Banana wilt in the Philippines. Philipp. Agr. Rev. **13**: 128, 129. 1920.
Caused by *Fusarium*.

Lee, H. A., & Yates, H. S. The distribution of pink disease. Philipp. Agr. Rev. 13: 115, 116. 1920.
Caused by *Corticium salmonicolor* B. & Br. on *Citrus*.

Legrand, J. F. Plantas utiles de Puerto Rico. Revista Agric. Puerto Rico. **5**[1]: 1–3; **5**[2]: 1–3; **5**[4]: 1–11; **5**[5]: 1–7. 1920. [Illust.]

Lemoine, Mme. Paul (Lemoine, Marie). Contribution à l'étude des Corallinacées fossiles. Bull. Soc. Géol. France IV. **17**: 233–277. "20 O 1918" [D 1918].

Lemoine, Mme. Paul (Lemoine, Marie). Les Mélobésiées des Antilles danoises récoltées par M. Boergesen. Bull. Mus. Hist. Nat. **1917**: 133–136. 1917.
Includes descriptions of new species in *Lithothamnium* (4), *Lithophyllum* (6). *Amphiroa* (1), *Corallina* (1), and *Arthrocardia* (1) from Martinique.

Levine, M. Studies on plant cancers—II. The behavior of crown gall on the rubber plant (*Ficus elastica*). Mycologia **13**: 1–11. *pl. 1, 2.* 3 F 1921.

Lindstrom, E. W. Chlorophyll factors of maize. Jour. Hered. **11**: 269–277. *f. 23–25.* 5 F 1921.
"Their distribution on the chromosomes and relation to the problem of inbreeding."

Löhnis, F., & Hansen, R. Nodule bacteria of leguminous plants. Jour. Agr. Research **20**: 543–556. *pl. 68, 69.* 3 Ja 1921.

Long, B. A further note on *Crepis biennis*. Rhodora **22**: 192, 193. 15 F 1921.

M[acoun], W. T. John Macoun, 1831–1920. Can. Field Nat. **34**: 110–114. 26 Ja 1921.

Marsh, C. D., & Clawson, A. B. *Daubentonia longifolia* (Coffee bean), a poisonous plant. Jour. Agr. Research **20**: 507–513. *pl. 62.* 15 D 1920.

Martin, W. H. A comparison of inoculated and uninoculated sulfur for the control of potato scab. Soil Sci. **11**: 75–84. *pl. 1 + f. 2.* Ja 1921.

Matz, J. Observaciones hechas en la region cerca de Maricao con respecto a las enfermedades del cafe y el guineo. Revista Agric. Puerto Rico **5**[5]: 15–18. 30 N 1920. [Illust.]

Mazza, A. Aggiunte al saggio di algologia oceanica. Nuova Notar. **32**: 1–48. 1921.

McAtee, W. L., & Metcalf, F. P. Notes on cockleburs (Ambrosiaceae, *Xanthium*) of the District of Columbia and vicinity. Proc. Biol, Soc. Washington **35**: 177–179. *pl. 4.* 30 D 1920.

McKay, M. B. Blossom-end rot of tomatoes. Oregon Crop Pest & Hort. Rep. **3**: 185, 186. 10 Ja 1921.

McKay, M. B. Mosaic disease of tomato. Oregon Crop Pest & Hort. Rep. **3**: 179–184. *pl. 14* + *f. 51, 52.* 10 Ja 1921.

McKay, M. B. Western yellow tomato blight. Oregon Crop Pest & Hort. Rep. **3**: 174–178. *f. 50.* 10 Ja 1921.

Melhus, I. E., & Gilman, J. C. Measuring certain variable factors in potato seed treatment experiments. Phytopathology **11**: 6–17. *f. 1–5.* Ja 1921.

Mendiola, N. B. On the evolution of the corn ear. Philipp. Agr. Rev. **13**: 112–114. *pl. 19–22.* 1920.

Mestre, A. Las leyes de la herencia y la biologia aplicada. Revista Fac. Letr. & Cienc. **27**: 163–193. *f. 1–14.* 1918.

Mestre, A. La vida d la "Sociedad Poey" de 1918 a 1919. Revista Fac. Letr. y Cienc. **29**: 153–171. 1919.

Mitra, S. K. Seasonal changes and translocation of carbohydrate materials in fruit spurs and two-year-old seedlings of apple. Ohio Jour. Sci. **21**: 89–103. *f. 1–7.* Ja 1921.

Mousley, H. The ferns of Hatley, Stanstead County, Quebec, 1920. Can. Field-Nat. **34**: 137–140. 9 F 1921.

Munns, E. N. High temperatures and eucalypts. Jour. For. **19**: 25–33. Ja 1921.

Murrill, W. A. A new bolete from Porto Rico, *Gyroporus Earlei* sp. nov. Mycologia **13**: 60, 61. 3 F 1921.

Murrill, W. A. The fruit-disease survey. Mycologia **13**: 50–53. *pl. 3.* 3 F 1921.

Murrill, W. A. An excursion to Mountain Lake, Virginia. Torreya **20**: 116–119. 5 F 1920.

Nelson, J. C. *Crepis setosa* in Oregon. Rhodora **22**: 191, 192. 13 F 1921.

Nelson, J. C. Does *saximontanus* mean "Rocky Mountain"? Rhodora **22**: 194, 195. 15 F 1921.

Nelson, J. C. Notes on *Scleropoa*. Torreya **20**: 119–122. 5 F 1921.

Nutting, C. C. Is Darwin shorn? Sci. Mo. **12**: 127–136. F 1920.

Osler, H. S. Origin and development of pedigreed varieties of grain. Ann. Rep. Michigan Acad. Sci. **21**: 139–143. Jl 1920.

Overholts, L. O. Some New Hampshire fungi. Mycologia **13**: 24–37. 3 F 1921.

Contains a list of 195 species.

Palmer, E. L. A talk on winter weeds. Cornell Rural School Leafl. 14: 165–220. Ja 1921. [Illust.]

Pearson, W. H. *Aplozia Pendletonii* Pearson. Bryologist **23**: 84, 85. *f. 1–3*. 8 F 1921.

Pearson, W. H. *Porella rivularis* (Nees) Lindb. Bryologist **23**: 85. 86. 8 F 1921.

Pease, V. A. Taxonomy and morphology of the ligulate species of the genus *Desmarestia*. Publ. Puget Sound Biol. Sta. **2**: 313–367. *pl. 54–63*. 30 D 1920.

Pegram, W. H., Wilson, R. U., & Patterson, A. H. James Jacob Wolfe. Jour. Elisha Mitchell Sci. Soc. **36**: 110–114. 1921. [With portrait.]

Pfeiffer, H. Cariceae Brasilienses maxime e civitate Paraná a P. Dusén reportatae. Repert. Sp. Nov. Regn. Veg. **17**: 28–32. 1 Ja 1921.

Includes 2 new species.

Piper, C. V. Plants and plant culture. Science II. **53**: 269–279. 25 Mr 1921.

Porsild, M. P. The structure and biology of Arctic flowering plants. 14. Liliales. Meddel. Grönland **37**: 343–358. *f. 1–8*. 1920.

Purpus, J. A. *Echinopsis caespitosa* J. A. Purpus spec. nov. Monatsschr. Kakteenk. **27**: 120. Au 1917. [Illust.]

Species from Bolivia.

Quehl, L. Kultur und Kulturgebnisse. Monatsschr. Kakteenk. **26**: 105–109; 125–127. 1916.

Describes flowers and fruits of various Cactaceae.

Quehl, L. *Echinocactus grandis* Rose. Monatsschr. Kakteenk. **27**: 86. Je 1917. [Illust.]

Quehl, L. *Mamillaria bombycina* Quehl. Monatsschr. Kakteenk. **26**: 50. Ap 1916.

Quehl, L. *Mamillaria Buchheimiana* Quehl spec. nov. Monatsschr. Kakteenk. **27**: 97–99. Jl 1917.

Quehl, L. *Mamillaria cornuta* Hildm. Monatsschr. Kakteenk. **27**: 126, 127. Au 1917.

Quehl, L. *Mamillaria Painteri* Rose spec. nov. Monatsschr. Kakteenk. **27**: 22. F 1917. [Illust.]

A Mexican species.

Rehfous, L. De l'action de conditions extrêmes sur la structure du stomate du "Zea Mays." Bull. Soc. Bot. Genève II. **12**: 110–121. *f. 1–10.* 31 Ja 1921.

Rehfous, L. Recherches experimentales sur la morphogénèse des stomates. Bull. Soc. Bot. Genève II. **12**: 93–109. *f. 1–24.* 31 Ja 1921.

Studied *Zea Mays* L.

Reinking, O. A. Higher Basidiomycetes from the Philippines and their hosts. IV. Philipp. Jour. Sci. **17**: 363–374. O 1920.

Riddell, W. R. The pharmacopoeia of another botanical physician. Trans. Bot. Soc. Edinburgh **28**: 1–23. 1920.

Discussion of 'The Vegetable Physician' by Samuel B. Emmons, Boston, 1836.

Riede, W. Untersuchungen über Wasserpflanzen. Flora **114**: 1–118. 1920.

Among plants studied is *Elodea densa* from South America.

Rolfe, R. A. *Odontoglossum Humeanum.* Bot. Mag. *pl. 8873.* 1920.

Of South Mexico.

Romell, L.-G. Physionomistique et écologie raisonnée. Svensk. Bot. Tidsks. **14**: 136–146. 1920.

Rosen, H. R. The behavior of telia of *Puccinia graminis* in the south. Mycologia **13**: 111–113. 26 Mr 1921.

Rowley, S. M. The cottonwoods of the dunes. Nat. Stud. Rev. **17**: 53–55. F 1921. [Illust.]

Rudolph, B. A., & Franklin, H. J. Studies of cranberries during storage. Fungi studies. Massachusetts Agr. Exp. Sta. Bull. 198: 88–92. *f. 1, 2.* S 1920.

St. John, H. A freak sweet clover. Rhodora **23**: 25, 26. 8 Mr 1921.

St. John, H. Sable Island, with a catalogue of its vascular plants. Proc. Boston Soc. Nat. Hist. **36**: 1–104. *pl. 1, 2.* 1921.

Includes *Rubus arcuans* Fernald & St. John, sp. nov., and 7 new varieties in various genera.

Salisbury, E. J. The significance of the calcicolous habit. Jour. Ecol. **8**: 202–215. 9 F 1921.

Schaffner, J. H. Influence of environment on sexual expression in hemp. Bot. Gaz. **71**: 197–219. *pl. 11* + *f. 1.* 17 Mr 1921.

Schlechter, R. Beiträge zur Kenntnis der Orchidaceenflora von Paraná (cont.). Repert. Sp. Nov. Regn. Veg. **16**: 316–334. 30 Ap 1920.

Includes 17 new species.

Schlechter, R. Orchidaceae novae et criticae.—Decas LXV. Repert. Sp. Nov. Regn. Veg. **16**: 353–358. 30 Ap 1920.

New American species in *Habenaria*, *Prescottia*, and *Aa*.

Schuchert, C. The evolution of primitive plants from the geologist's viewpoint. New Phytol. **19**: 272–275. 31 Ja 1921.

Schwappach, A. F. Beiträge zur Kenntnis der Wachtumsleistungen von *Pseudotsuga Douglasii*. Mitt. Deutsch. Dend. Ges. **1920**: 262–269. 1920.

Schwerin, F. von. Die Formen der *Picea pungens*. Mitt. Deutsch. Dend. Ges. **1920**: 231–235. 1920.

Includes several new American forms.

Schwerin, F. von. Revisio generis *Sambucus*. Mitt. Deutsch. Dend. Ges. **1920**: 194–231. 1920. [Illust.]

Includes *Sambucus Rehderana*, sp. nov., from Texas, and several new American varieties and forms.

Sears, P. B. Variation in *Taraxacum*. Science II. **53**: 189. 25 F 1921.

Setchell, W. A. Marine algae and terrestrial plants of Tutuila, Samoa. Carnegie Inst. Washington Year Book **19**: 198, 199. 3 F 1921.

Shaw, R. H., & Wright, P. A. A comparative study of the composition of the sunflower and corn plants at different stages of growth. Jour. Agr. Research **20**: 787–793. 15 F 1921.

Shreve, E. B. Causes of the seasonal changes in the transpiration of *Encelia farinosa*. Carnegie Inst. Washington Year Book **19**: 73–75. 3 F 1921.

Shreve, F. Ecology of the Santa Lucia Mountains [California]. Carnegie Inst. Washington Year Book **19**: 78, 79. 3 F 1921.

Shreve, F. The vegetation of a desert valley [near Tucson, Arizona]. Carnegie Inst. Washington Year Book **19**: 77, 78. 3 F 1921.

Shunk, I. V. Notes on the flagellation of the nodule bacteria of Leguminosae. Jour. Bact. **6**: 239–246. *pl. 1*. 1921.

Skottsberg, C. Remarks on *Splachnidium rugosum* (L.) Grev. Svensk. Bot. Tidskr. **14**: 271–278. *f. 1–5*. 1920.

Speare, A. T. *Massospora cicadina* Peck. Mycologia **13**: 72–82. *pl. 5, 6*. 26 Mr 1921.

A fungous parasite of the periodical cicada.

Spoehr, H. A. Interrelation of photosynthesis and respiration. Carnegie Inst. Washington Year Book **19**: 64. 3 F 1921.

Spoehr, H. A. & McGee, J. M. Rate of respiration of leaves in relation to amino-acid and carbohydrate content. Carnegie Inst. Washington Year Book **19**: 63, 64. 3 F 1921.

Sprenger, C. Beobachtungen an einigen *Yucca*-Arten. Mitt. Deutsch. Dend. Ges. **1920**: 138–149. 1920.

Sprenger, C. Mitteilungen über meine *Yucca*-Hibriden und -Formen. Mitt. Deutsch. Dend. Ges. **1920**: 96–138. *pl. 21, 22.* 1920.

Stahel, G. De Zeefvatenziekte (Phloëemnecrose) van de Liberiakoffie in Suriname. Dept. Landb. Suriname Bull. **40**: 1–26. Mr 1920. [Illust.]

Standley, P. C. Some interesting plants in Glacier Park, Montana. Gard. Chron. III. **78**: 275. 4 D 1920.

Stevenson, J. A. Enfermedades del citro en Puerto Rico. Rev. Agric. Puerto Rico **4**, no. 3: 34–46; no. 4: 25–36; no. 5: 22–27. 1920.

Taylor, A. M. Occurrence of *Funaria hygrometrica* (L.) Sibth. Bryologist **24**: 7, 8. 22 Mr 1921.

Teuscher, H. Die Unterscheidungsmerkmale der häufigsten *Larix*-Arten. Mitt. Deutsch. Dend. Ges. **1920**: 69–72. 1920.

Thielmann, —. Ein riesiges *Taxodium mexicanum.* Mitt. Deutsch. Dend. Ges. **1920**: 326. *pl. 30.* 1920.

Thom, C., & Church, M. B. *Aspergillus flavus, A. Oryzae*, and associated species. Am. Jour. Bot. **8**: 103–126. *f. 1.* 19 Mr 1921.

Torrey, R. E. *Telephragmoxylon* and the origin of wood parenchyma. Ann. Bot. **35**: 73–77. *pl. 3* + *f. 1–3.* Ja 1921.

Telephragmoxylon, gen. nov., from the Comanchean deposits of Texas.

Vaupel, F. *Echinocereus subinermis* S.-D. Monatsschr. Kakteenk **26**: 98. Jl 1916. [Illust.]

Vaupel, F. Neue südamerikanische Kakteen. Monatsschr. Kakteenk. **26**: 120–125. 15 Au 1916.

Species of *Cereus* (4) and *Echinocactus* (1).

Wann, F. B. The fixation of free nitrogen by green plants. Am. Jour. Bot. **8**: 1–29. *pl. 1.* 9 Mr 1921.

Species of Chlorophyceae studied experimentally.

Waters, C. E. More about early days of the American Fern Society. Am. Fern Jour. **11**: 16–19. Mr 1921.

Waters, C. E. The ferns of Baltimore [Maryland] and vicinity. Am. Fern Jour. **11**: 19–25. Mr 1921.

Vol. 48 No. 8

BULLETIN

OF THE

TORREY BOTANICAL CLUB

AUGUST, 1921

Studies in the genus Lupinus—VI. The Stiversiani, Concinni and Subcarnosi

CHARLES PIPER SMITH

(WITH EIGHT TEXT FIGURES)

INTRODUCTION

The three groups treated in this paper have little in common except that they are annuals or biennials with non-verticillate flowers. Each group is monospecific, as I see it, but botanists have seen as many as six species in the variable *L. concinnus* and four species in the likewise variable *L. subcarnosus*.

These groups may be contrasted as follows:

Racemes shorter than their peduncles; keel petals densely ciliate near the claw, on both upper and lower edges. STIVERSIANI.

Racemes longer than their peduncles; keel petals naked on both upper and lower edges.

Leaflets 2–5 mm. wide; pods 10–15 mm. long; seeds 1.5–3 mm. long. CONCINNI.

Leaflets 6–12 mm. wide; pods 30–50 mm. long; seeds 4–6 mm. long. SUBCARNOSI.

STIVERSIANI

1. LUPINUS STIVERSI Kellogg, Proc. Cal. Acad. I. **2**: 192. 1892. [FIG. 67.]

Erect, the few to several branches ascending, 15–45 cm. tall, canescent; leaves scattered, appressed-pubescent on both sides, petioles 3–8 cm. long, leaflets six to seven, obovate to cuneate, obtuse at apex, 12–40 mm. long, 4–8 mm. wide; peduncles 3–8 cm. long, racemes 1–3 cm. long, few-flowered; flowers about 15 mm. long, pedicels about 2 mm. long, appressed-pubescent; calyx with or without bractlets, upper lip 4–6 mm. long, bifid, lower lip

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entire or minutely three-toothed, 5–8 mm. long; banner 13–15 mm. long, 9–10 mm. wide, bright yellow, wings 16 mm. long, rose-pink or purple, sometimes ciliate on the basal tooth, keel whitish, strongly ciliate toward the base both above and below, the lower fringe running out along the claw; pods about 20 mm. long, ovules five to seven; seeds about 2.5 x 2 mm., flat, angled, dark-spotted on a pale ground.

This very unique and handsome species belongs primarily to the western slopes of the Sierras, from Butte County to Kern County, but also occurs locally in the San Bernardino Mountains and in the Santa Lucia Mountains of Monterey County.

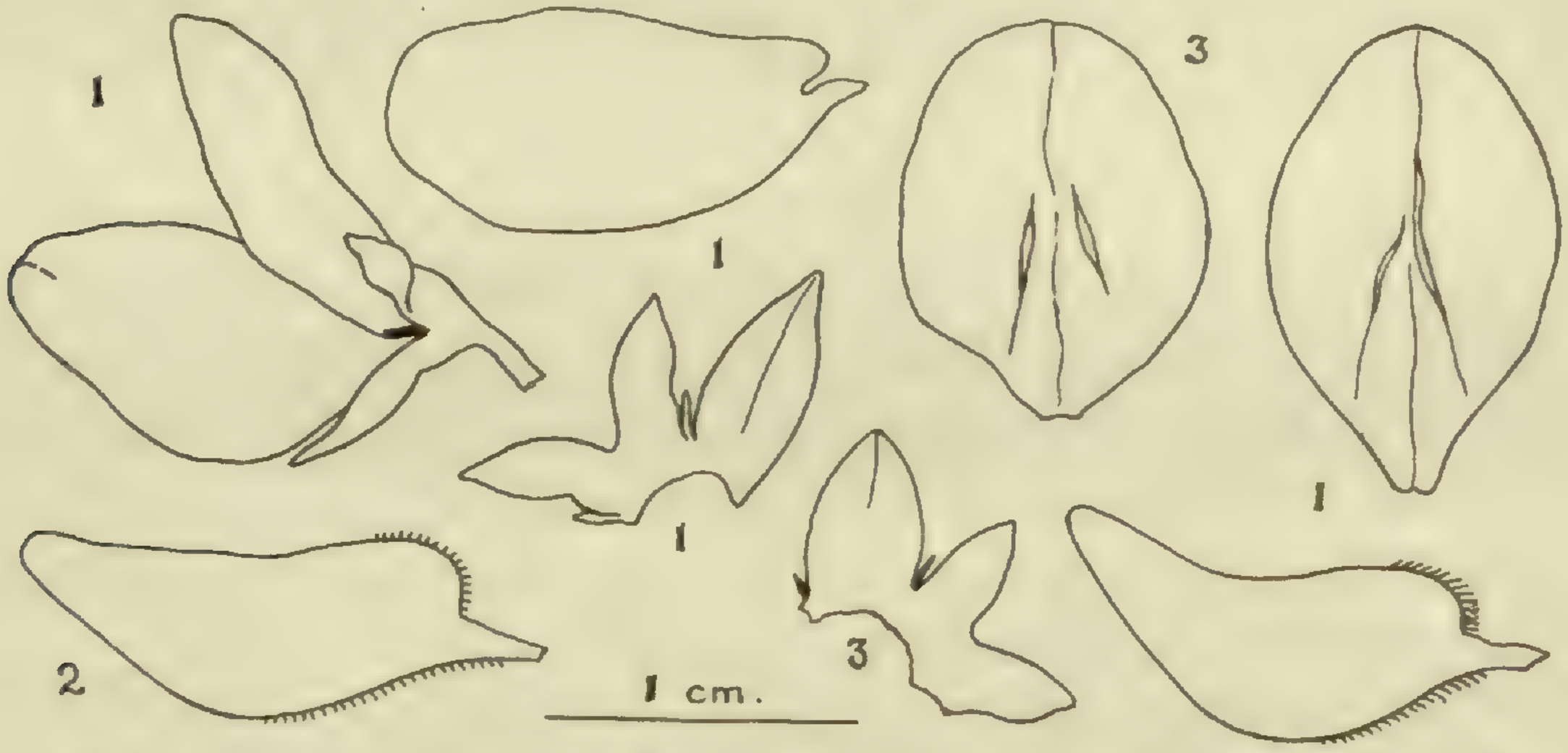

FIG. 67. LUPINUS STIVERSI Kellogg. 1. *J. W. Congdon* (US 466506); 2. *G. Hansen 18* (US); 3. *A. D. E. Elmer 3271* (US).

CALIFORNIA. Amador County: New York Falls, April, 1891, *G. Hansen* (DS); same locality, April, 1893, *G. Hansen 18* (UC); same locality, May, 1895 (US). Butte County: Brush Creek, 1907, *Kate Conger* (UC); Nimshew, May, 1918, *Alethea Beagles & G. P. Van Eseltine* (CPS). El Dorado County: Pyramid Peak, 1900, *W. L. Atkinson* (DS); Tahoe road, fifteen miles above Placerville, May, 1907, *K. Brandegee* (UC); same locality, May, 1903, *C. A. Gross 95* (DS). Fresno County: between Sauger and Sequoia Mills, May, 1894, *A. Eastwood* (G); Pine Ridge, June, 1900, *Hall & Chandler 205* (DS, NY, UC, US). Kern County: Green Horn Mountains, June, 1888, *E. Palmer 115* (T); Kernville, *T. S. Brandegee* (G). Madera County: North Fork and vicinity, May–June, 1903, *D. Griffith 4457* (US); Shuteye Mountain, July, 1907, *J. Murdock, Jr. 2514* (G). Mariposa County: Clarks, on branch of Merced River, 1872, *A. Gray* (G); same locality, June,

1881, *C. C. Parry 39* (G); Culip, March, 1883, *J. W. Congdon* (NY); Mariposa, March, 1883, *J. W. Congdon* (US); same locality, May, 1903, *J. W. Congdon* (B); Morman Bar, May, 1892, *J. W. Congdon* (DS); Pea Ridge road, April, 1901, *J. W. Congdon* (US); same locality, May, 1902, and April, 1903, (B); Toll House road, May, 1903, *J. W. Congdon* (G); Wawona flats, July, 1919, *S. S. Towne & E. P. Chace* (CPS); Yosemite, 1884, *M. K. Curran* (US); same locality, July, 1907, *M. Alice King* (UC); same locality, *K. Brandegee* (DS); same locality, near Hog Ranch, July, 1902, *Hall & Babcock 3306* (G, RM, UC, US); Yosemite Valley, 1868, *J. Torrey* (G, NY, T); same locality, June, 1911, *L. R. Abrams 4474* (DS, G) and *H. M. Hall 8870* (DS, G, UC, US); same locality, Royal Arches, June, 1912, *E. A. Babcock 1074* (RM, UC). Monterey County: Little Sur, May–June, 1901, *J. B. Davy 7393* (UC); San Antonio school house, May, 1895, *W. R. Dudley* (DS); Tassajara Hot Springs, June, 1901, *A. E. D. Elmer 3271* (DS, US). Placer County: Auburn, April, 1919, *G. Bankey* (DS); Bear Valley, 1872, *Bolander & Keller* (T); same locality, near Fowler, June, 1894, *Martha Brier* (UC); ——, 1893, *Mrs. M. M. Hardy* (T, UC). San Bernardino County: San Bernardino Mountains, Grass Valley, June, 1894, *S. B. Parish 3111* (G, NY, T, UC). Tulare County: North Fork Kern River, June, 1888, *E. Palmer 115* (US); Bear Creek, May, 1896, *C. A. Purpus 1725* (UC); Grape Vine Spring, east of Visalia, March, 1898, *P. S. Woolsey* (UC); Sequoia National Park, July, 1914, *Myrtle Lathrop* (CPS). Tuolumne County: near Cherry River, June, 1889, *Chesnut & Drew* (UC); near Big Oak Flat, May, 1895, *W. C. Blasdale* (UC); Five Mile Creek, May, 1916, *A. L. Grant* (DS); above Rawhide, April, 1919, *R. S. Ferris 1480* (DS).

CONCINNI

This group is based upon two closely related forms collected by Douglas in California and described by Agardh from specimens in Lindley's herbarium. A review of this group necessitates accounting for the following names:

L. concinnus Agardh, Syn. Gen. Lup. 6. *pl. 1, f. 1.* 1835.
L. gracilis Agardh, *ibid.* 15. *pl. 1, f. 2.* 1835.
L. Orcuttii Wats. Proc. Am. Acad. **20**: 359. 1885.

L. pallidus Brandegee, Zoe 4: 203. 1893.
L. micensis Jones, Proc. Cal. Acad. I. 5: 630. 1895.
L. desertorum Heller, Muhlenbergia 2: 72. 1905.
L. Agardhianus Heller, *ibid.* 7: 13. 1911.

Heller has shown that Nuttall's *L. gracilis*, of the Gulf States, has priority over *L. gracilis* Agardh, hence the second name of the above list is properly replaced by the last one given. Agardh very obligingly contrasts his two species on one and the same plate, and careful comparison of his two descriptions discovers no marked differences other than those shown by his drawings. The odd fact is that he classifies *L. concinnus* in his group "B" (*Pilosi*) and his *L. gracilis* in his group "E" (unlettered and unnamed, but plainly provided for in his arrangement).

This group is primarily Californian, ranging from Monterey County to northern Lower California, just two forms having an extensive range into the Mexican Plateau region, as far north as southern Utah, east to southern New Mexico, and south into Sonora.

The pubescence varies from long-villous to subappressed, and the habit from erect and simple to much branched with the lower branches widely spreading. Some of the axillary branches are occasionally reduced to mere racemes, and even more often to one or two axillary flowers, which develop normal pods and seeds: hence the character, "racemes . . . sessile in the axils," ascribed by Watson to his *L. Orcuttii*. The flowers are usually small, 7–9 mm. long, but conspicuously larger in a form of the San Bernardino and the San Jacinto Mountains. The petals vary from white and yellowish to a bright blue or a rich reddish purple, variously designated by authors. Few other characters seem to be marked enough to justify their use in diagnoses, and I must admit that the six forms which I am able to recognize are so closely related to each other that their relationship seems to me to be best expressed by classifying them all as varieties of one species. I cannot appreciate color alone as of sufficient value to warrant specific distinctions, and the variable pubescence here, as in *L. densiflorus*, *L. sparsiflorus*, etc., seems to prohibit positive lines of separation.

Key to the varieties of Lupinus concinnus

Densely villous with hairs 1–2.5 mm. long; petals more or less reddish purple; banner 6–10 mm. long, 3–9 mm. wide, mostly with rounded or emarginate apex.
Flowers 6–7 mm. long; banner about 6 mm. long and 3 mm. wide. *2b.* var. *Orcuttii.*
Flowers 7–12 mm. long; banner 4–9 mm. wide.
Flowers 7–9 mm. long; banner 7–8 mm. long and 4–5 mm. wide. *2a. L. concinnus.*
Flowers 10–12 mm. long; banner 9–10 mm. long and 7–9 mm. wide. *2c.* var. *optatus.*
Loosely villous or mostly appressed-pubescent; banner 6–7 mm. long, 3–4 mm. wide, mostly with angled apex.
Pubescence obviously spreading; petals reddish purple or blue-edged. *2d.* var. *Agardhianus.*
Pubescence mainly appressed; petals white or yellowish.
Leaflets 5–6, spatulate, obtuse at apex. *2e.* var. *pallidus.*
Leaflets 6–9, oblong-lanceolate, angled at apex. *2f.* var. *desertorum.*

2a. LUPINUS CONCINNUS Agardh, Syn. Gen. Lup. 6. *pl. 1, f. 1.* 1835. [FIG. 68.]

Simple or much branched from the base, 6–20 cm. tall, densely villous, the spreading hairs 1–3 mm. long: leaves numerous, very villous, the petioles two to four times as long as their longest leaflets, which are five to eight, oblanceolate with obtuse apex, 10–20 mm. long, 2–5 mm. wide; racemes nearly sessile, 3–6 cm.

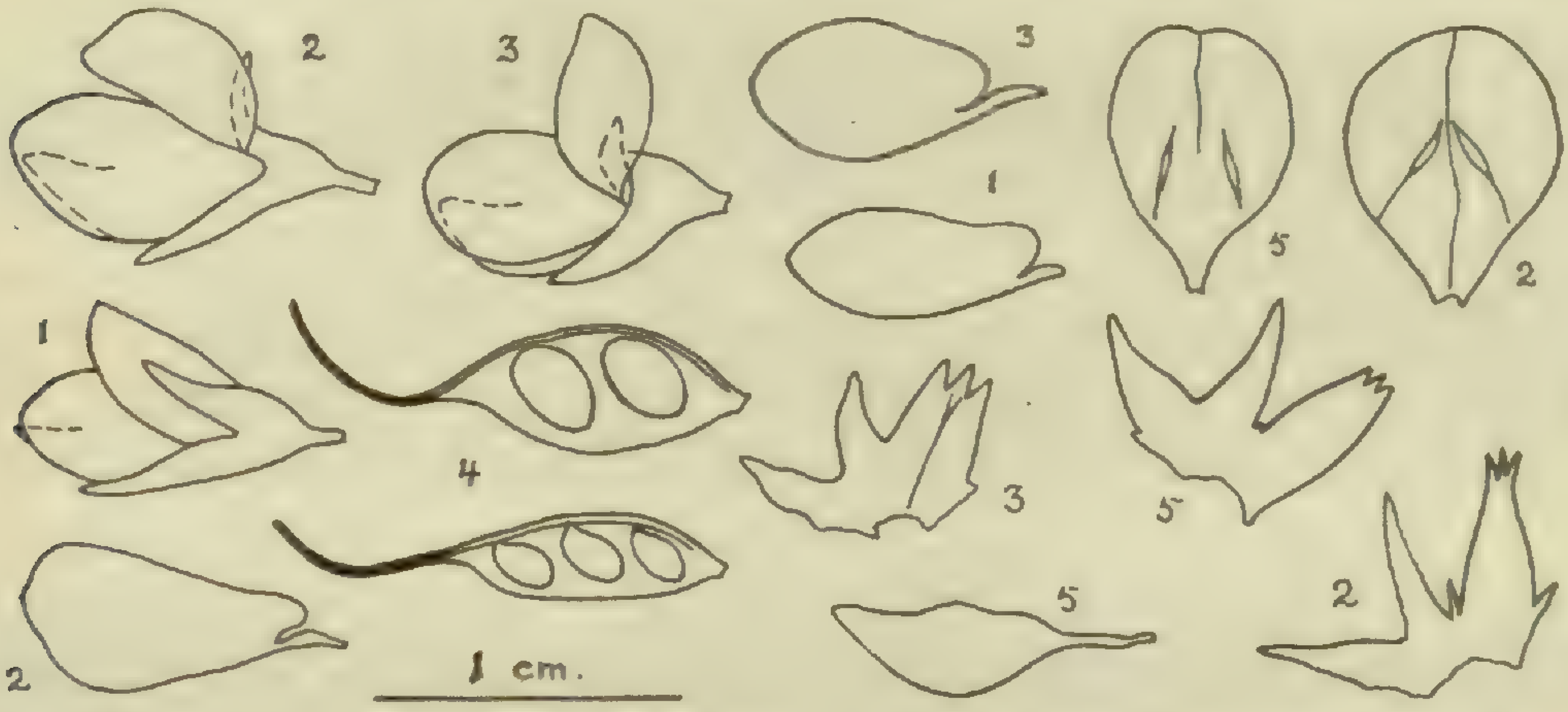

FIG. 68. LUPINUS CONCINNUS Agardh. 1. *A. D. E. Elmer 3279* (US); 2. *L. R. Abrams 3564* (US); 3. *E. O. Wooton* (US 241176); 4. *C. R. Orcutt* (US 21071); 5. *T. S. Brandegee* (US 735428).

long, surpassed by the leaves; flowers 7–9 mm. long, usually well scattered, pedicels about 1 mm. long, stout, densely villous; calyx also densely hairy, upper lip bifid, about 4 mm. long, lower lip three-toothed, somewhat longer; petals edged with rich reddish purple, banner 7–9 mm. long, 4–5 mm. wide, rounded or emarginate at apex, wings 7–8 mm. long, about 3 mm. wide, keel

usually straight, 6–7 mm. long, about 2 mm. wide, naked: pods oblong, 10–15 mm. long, ovules two to four; seeds 2–3 mm. long, angled, nearly square, mostly dull-spotted on a pale ground.

CALIFORNIA. Imperial County: Coyote Wells to Cement Bridge, April, 1917, *E. A. McGregor 841* (DS); Live Oak Springs, June, 1917, *E. A. McGregor 907* (DS). Kern County: Bakersfield, April–May, 1896, *J. B. Davy 1800* (UC); Kernville, May, 1911, *K. Brandegee* (UC); Tehachapi, no date, *K. Brandegee* (DS). Los Angeles County: Antelope Valley, May, 1896, *J. B. Davy 2321* (UC); same locality, Richardson's Canyon, May, 1896, *J. B. Davy 2495* (G, UC); Catalina Island, September, 1893, *A. J. McClatchie* (NY); Liebre Mountains, June, 1908, *Abrams & McGregor 374* (DS); Mount Wilson, May, 1896, *A. J. McClatchie* (NY). Monterey County: Los Burros Mines, April, 1898, *R. A. Plaskett* (G, RM); San Antonio Creek, May, 1895, *W. R. Dudley* (DS); San Antonio River, March, 1920, *C. D. Duncan 52* (DS); Tassajara Hot Springs, June, 1901, *A. D. E. Elmer 3279* (DS, US). Riverside County: Cottonwood Mountains, May, 1905, *H. M. Hall 6022* (B, UC); San Jacinto River, March, 1896, *A. J. McClatchie 1136* (NY); May, 1904, *H. M. Hall 4945* (DS). San Bernardino County: Cajon Pass, April, 1902, *H. M. Hall 3006* (UC); Colton, April, 1882, *M. E. Jones 3196* (G, NY, US); Ord Mountains, toward Kane Spring, May, 1906, *Hall & Chandler 6792* (B); San Bernardino, 1880, *W. G. Wright 9*, (G); Santa Ana Canyon, April, 1898, *G. Robertson* (UC); Skyland, June, 1913, *H. P. Chandler 2* (UC). San Diego County: Campo, May, 1903, *L. R. Abrams 3564* (DS, G, NY, US); Coyote Canyon, April, 1902, *H. M. Hall 2820* (UC); Jacumba Hot Springs, May, 1894, *L. Shoemfeldt, Int. Bound. Comm. 3268* (US); Jacumba, April, 1905, *T. S. Brandegee* (US); San Felipe, 1899, *K. Brandegee* (UC); San Jacinto Mountains, June, 1897, *G. F. Reinhardt* (UC); same locality, May, 1897 and 1899, and June, 1901, *H. M. Hall 547* (US), *1128* (NY), and *2067* (DS); Stonewall, June, 1894, *T. S. Brandegee* (UC); Tia Juana Wash, April, 1903, *H. M. Hall 3970* (G, UC); 1889, *C. R. Orcutt* (US 40871). Santa Barbara County: near Santa Barbara, 1894, *F. Franceschi* (UC); San Rafael Mountains, 1889, *H. C. Ford* (G.) County not determined: Burnett Creek, April, 1901, *W. R. Dudley* (DS); Erskin Creek,

hillsides, 1897, *C. A. Purpus* 5363 (G, UC, US); no locality or date, *D. Douglas* (T).

LOWER CALIFORNIA. Cantillas Mountains, July, 1884, *C. R. Orcutt* (US); north of Hansen's ranch, April, 1885, *C. R. Orcutt 1262* (G).

ARIZONA. Mohave County: Peach Spring, April, 1893, *N. C. Wilson* (UC). Pima County: Santa Catalina Mountains, April, 1895, *J. W. Toumey* (NY, UC); Santa Rita Forest, March-April, 1903, *D. Griffiths 4210* (US). County not determined: Copper Basin, June, 1892, *J. W. Toumey 574* (US); Lynx Creek, May, 1893, *H. H. Rusby* (US, T); Saginaw Mine Trip, March, 1901, *D. Griffiths 2492* (NY).

NEW MEXICO. Dona Ana County: Organ Mountains, May, 1892, 1893 and 1900, *E. O. Wooton* (US). Grant County: Mangas Springs, May, 1903, *O. B. Metcalfe 69* (G, NY, RM, UC, US).

2b. **Lupinus concinnus Orcutti** (Wats.) comb. nov. [FIG. 69.]

Lupinus Orcuttii Wats. Proc. Am. Acad. **20**: 359. 1885.
Lupinus micensis Jones, Proc. Cal. Acad. II. **5**: 630. 1895.

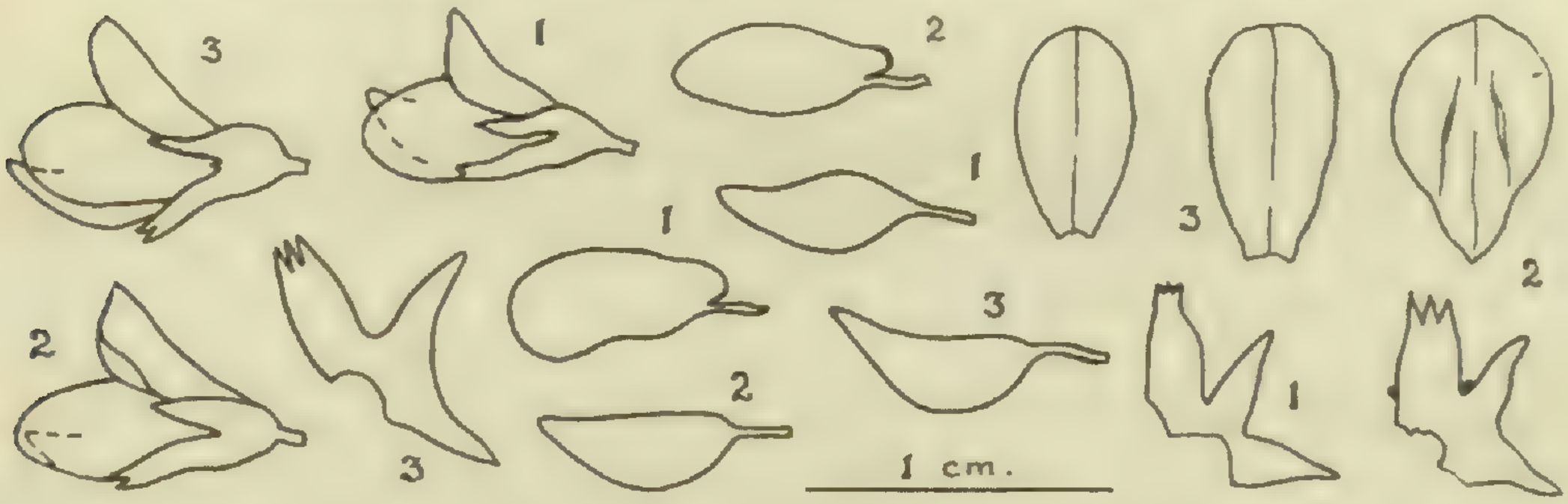

FIG. 69. LUPINUS CONCINNUS ORCUTTII (Wats.) C. P. Smith. 1. *M. E. Jones 5163g* (US); 2. *Rose, Standley & Russell 15089* (US); 3. *E. A. Mearns, I.B.C. 3482* (US).

Differs from typical *L. concinnus* only in being commonly more congested and with smaller flowers, 6–7 mm. long, banner narrower, about 3 mm. wide.

My determination of Watson's species is based upon the Gray Herbarium sheet of the only collection cited by him, while I have judged Jones's species from his several specimens in the United States National Herbarium. I see no substantial differences between the specimens concerned, and Watson's assignment of his species to the subgenus *Platycarpos* I cannot accept.

CALIFORNIA. Inyo County: Pleasant Canyon, Panamint Mountains, May, 1906, *Hall & Chandler 6955* (UC). Kern County: Caliente, no date, *K. Brandegee* (UC). Monterey County: Santa Lucia Mountains, Burro Trail, June, 1909, *K. Brandegee* (UC). San Bernardino County: Bagdad, May, 1902, *T. S. Brandegee* (UC): Barnwell, May, 1911, *K. Brandegee* (UC); Daggart, no date, *K. Brandegee* (UC); Goffs, March, 1915, *S. B. Parish 9657* (UC); Morongo, Colorado Desert, March, 1882, *S. B. Parish 1270** (NY); San Bernardino, March, 1915, *S. B. Parish* (UC); Warren's Well, May, *T. S. Brandegee* (UC). San Diego County: Colorado Desert, *C. R. Orcutt* (G); San Felipe, April, 1894, *T. S. Brandegee* (UC). Santa Barbara County: Cuyama, May, 1896, *A. Eastwood* (G); Santa Cruz Island, April, 1888, *T. S. Brandegee* (UC). Tulare County: North Fork Kern River, 1898, *C. A. Purpus* (UC). Ventura County: Ojai, Matilija Canyon, April, 1866, *S. F. Peckham* (US). County not determined: April, 1901, *G. B. Grant 3793* (US).

LOWER CALIFORNIA. Japa, July, 1884, *C. R. Orcutt 1133* (G, NY); Nachoguero Valley, June, 1894, *E. A. Mearns, Int. Bound. Comm. 3482* (US).

SONORA. Magdalena, April, 1910, *Rose, Standley, & Russell 15089* (US); Santa Cruz River Valley, May, *E. K. Smith* (T).

ARIZONA. Cochise County: Benson, April, 1905, *T. E. Wilcox* (US); Fort Huachuca, April, 1892, *T. E. Wilcox* (T, UC); same locality, 1894, *T. E. Wilcox 37* (US). Maricopa County: Camp Lowell, April, 1881, *C. G. Pringle* (NY, T); same locality, May, 1883, *C. G. Pringle* (UC). Mohave County: Yucca, May, 1884, *M. E. Jones 3898* (NY, RM, US). Pima County: Loasa to Lavare via Baboquivari, March–April, 1903, *D. Griffiths 3616* (US); Sabina Canyon, April, 1892, *J. W. Toumey* (DS, UC); Santa Rita Forest, March–April, 1903, *D. Griffiths 3849* (US); Tucson, March, 1877, *E. L. Greene 1066* (G); same locality, March–April, 1903, *D. Griffiths 3533* (US); Tucson Range Reserve, March, 1901, *D. Griffiths 2387* and *2554* (NY). Santa Cruz County: Crittenden, May, 1892, *T. S. Brandegee* (UC); Nogales to Calabasas, April, 1908, *I. Tidestrom 799* (US); Nogales, hills

* Two specimens of *L. Shockleyi* and one specimen each of *L. odoratus* and *L. microcarpus ruber* are also mounted on this sheet.

east, March, 1908, *I. Tidestrom 720* (US). Yavapai County: Prescott, April, 1876, *E. Palmer* (G). County not determined: Agua Verda Creek, March, 1914, *J. A. Harris C1489* (US); Oracle to Redington, March–April, 1903, *D. Griffith 3731* (US); Pagumpa, April, 1894, *M. E. Jones 5095b* (US); 1869, *E. Palmer* (US 20944, lower specimen only); 1876, *E. Palmer 83* (US 21025).

NEW MEXICO. Luna County: Florida Mountains, March, 1897, *C. L. Herrick 323* (US).

UTAH. Washington County: Silver Reef, May, 1894, *M. E. Jones 5149h, 5163g, 5176j* (US); St. George, 1877, *E. Palmer 87* (G, T, US); same locality, 1919, *I. Tidestrom 9260* (US, CPS).

NEVADA. Clark County: Mica Spring, April, 1894, *M. E. Jones 5045f* and *5072b* (US). Nye County: Rhyolite, May, 1909. *A. A. Heller 9681* (B).

2c. **Lupinus concinnus optatus** var. nov. [FIG. 70.]

A *L. concinni* differt altitudine 20–30 cm.; floribus 10–12 mm. longis, vexillo 9–10 mm. longo, 7–9 mm. lato, apice emarginato, alis 10 x 6 mm., carina 9 mm. longa.

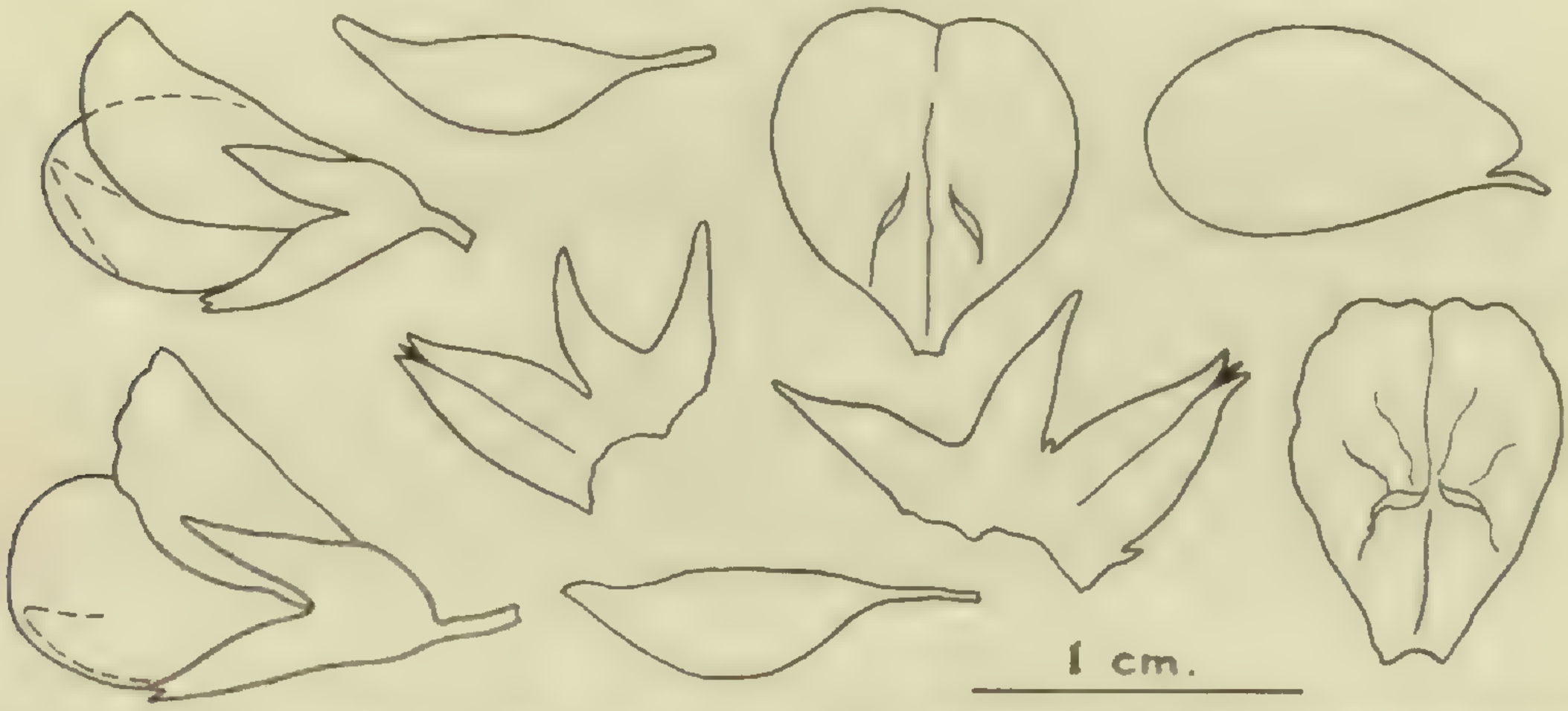

FIG. 70. LUPINUS CONCINNUS OPTATUS C. P. Smith. *S. B. Parish 3055* (US).

Differs from the typical plant in being taller and more robust throughout; flowers 10–12 mm. long, banner 9–10 mm. long, 7–9 mm. wide, mostly emarginate at apex, wings 10 x 6 mm. and keel 9 mm. long.

Presumably a mountain-valley form inhabiting areas of greater rainfall or abundant seepage.

CALIFORNIA. Monterey County: Santa Lucia Mountains, Plaskett Trail, May, 1897, *A. Eastwood* (G, G). Riverside County: Banning, *M. F. Gilman 5* (UC); Fairmount Park, May,

1904, *H. M. Hall 4945* (B, UC); same locality, May, 1907, *F. M. Reed 1332* (B); San Jacinto, 1890, *Mrs. Gregory* (UC). San Bernardino County: Colorado Desert, April, 1889, *C. R. Orcutt* (US); San Bernardino, June, 1876, *J. G. Lemmon* (DS); San Bernardino Mountains, May, *Clara E. Cummings* (G); same locality, May, 1880, *G. R. Vasey 95* (US); same locality, June, 1888, *S. B. Parish* (UC); same locality, Fredalba, July, 1908, *H. M. Hall 8942* (NY, US); same locality, Grass Valley, June, 1894, *S. B. Parish 3055* (TYPE, US 214651); same locality, Hunsacker Flat, June, 1916, *H. P. Chandler 9* (UC); same locality, south slope, March, 1906, *S. B. Parish 5761* (B, RM); Mojave River headwaters, May, 1881, *S. B. & W. F. Parish 94* (T); Victorville, April, 1919, *P. A. Munz 2590* (DS). San Diego County: Cuyamaca, July, 1906, *K. Brandegee* (UC); Descanso, May, 1906, *T. S. Brandegee* (NY, UC); Jacumba, April, 1905, *T. S. Brandegee* (UC); Santa Ysabel, April, 1893, *H. W. Henshaw 140* (US); Warner's ranch, May, 1899, *H. M. Hall 1373* (UC); Witch Creek, May, 1894, *R. D. Alderson* (UC). County not determined: San Emigdio Canyon, May, 1896, *J. B. Davy 2061* (UC); 1876, *Parry & Lemmon 64* (G, T); *Dr. Coulter* (T); *H. P. Chandler 1498* (UC); *S. B. Parish* (US 136782); 1889, *C. R. Orcutt* (US 40870, left-hand specimen only).

2d. **Lupinus concinnus Agardhianus** (Heller) comb. nov. [FIG. 71.]

Lupinus gracilis Agardh, Syn. Gen. Lup. 15. *pl. 1, f. 2.* 1835.

Lupinus Agardhianus Heller, Muhlenbergia 7: 13. 1911.

Differs from the typical *L. concinnus* in being usually more slender, less branched, and of open habit; petals edged with rose-purple or sometimes bright blue; pubescence spreading, but much less dense; banner usually acute at apex.

Agardh's plate and description seem to abundantly warrant the usual determinations here accepted by me.

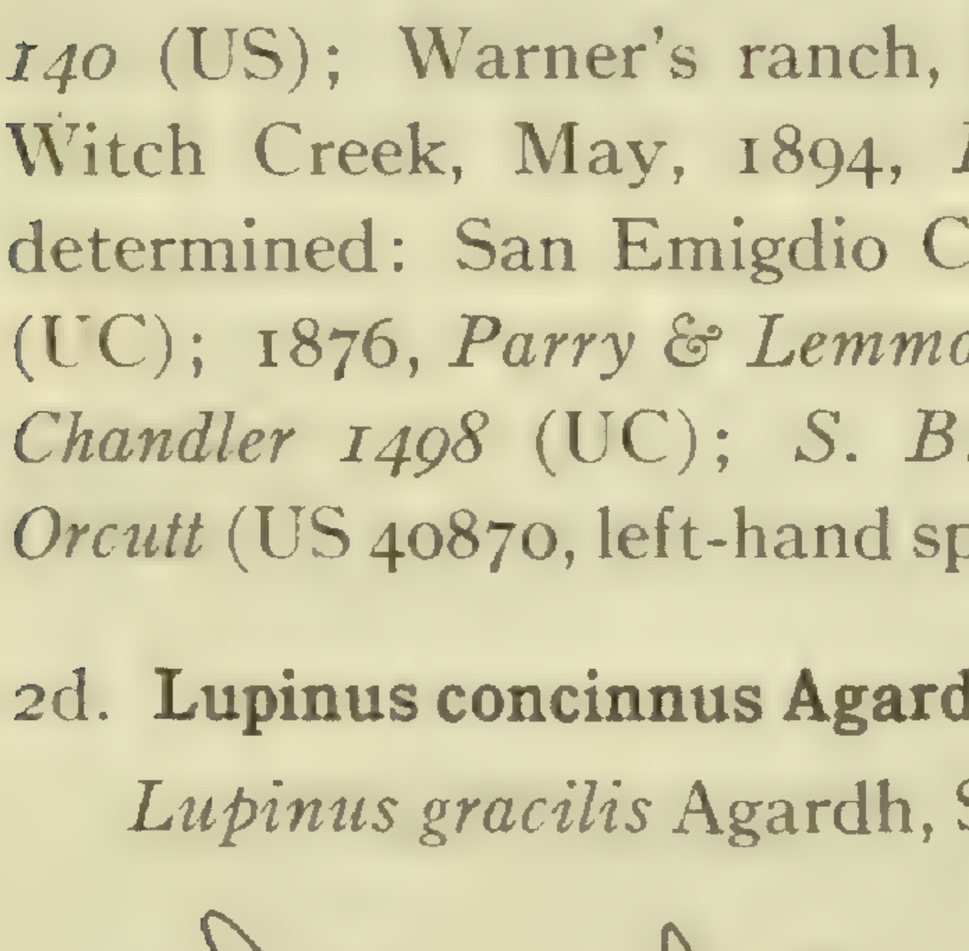

FIG. 71. LUPINUS CONCINNUS AGARDHIANUS (Heller) C. P. Smith. 1. *H. M. Hall 3862* (US); 2. *C. R. Orcutt* (US 40870, right hand specimen)

CALIFORNIA. Kern County: Fort Tejon and vicinity, 1857–58, *L. J. Xantus de Vesey* (G). Los Angeles County: Avalon, Santa Catalina Island, May, 1897, *B. Trask* (US); Manzana, Antelope Valley, May, 1896, *J. B. Davy 2499* (UC); San Fernando Mountains near Chatsworth Peak, April, 1901, *L. R. Abrams 1365* (DS, G, NY). Monterey County: near Monterey, 1850, *Rev. S. H. Willey* (G); Carmel-by-the-Sea, April, 1910, *A. D. Randall* (DS). San Bernardino County: Cajon Pass, April, 1881, *C. G. Pringle 36* (G); same locality, April, 1902, *H. M. Hall 3005* (B, G, UC); May, 1903, *M. E. Jones* (UC); Mojave Desert, near Cajon Pass, May, 1914, *S. B. Parish 9255* (NY); San Bernardino, May, 1880, *G. R. Vasey* (US). San Diego County: Banner, April, 1899, *K. Brandegee* (UC); Campo, May, 1903, *L. R. Abrams 3566* (DS, G, NY, UC, US); Carriso Creek, April, 1893, *T. S. Brandegee* (UC); Coyote Canyon, April, 1902, *H. M. Hall 2821* (UC); Dulzura, 1903, *Mr. Valentine* (UC); La Jolla, March, 1914, *F. E. & E. S. Clements 150* (G); Point Loma, March, 1895, *T. S. Brandegee* (UC); Poway, April, 1903, *H. M. Hall 3862* (B, G, US); San Diego, April, 1902, *G. B. Grant 1404* (UC, US); same locality, April, 1906, *K. Brandegee* (B, UC); same, May, 1906, *T. S. Brandegee* (B, NY); southwestern Colorado Desert, April, 1889, *C. R. Orcutt* (G, US 40870, right-hand specimen only); Witch Creek, April, 1894, *R. D. Alderson* (UC). San Luis Obispo County: Estrella (received Feb. 22, 1897), *L. Jared* (UC); San Luis Obispo district, June, 1876, *E. Palmer 95* (UC). Santa Barbara County: Aloma Creek, *C. Cox* (UC); Santa Barbara, *S. F. Peckham* (NY). Ventura County: Ojai Valley, April, 1896, *F. W. Hubby 38* (UC).

LOWER CALIFORNIA. San Quentin Bay, Feb., 1889, *E. Palmer 708* (US).

2e. **Lupinus concinnus pallidus** (Brandegee) comb. nov. [FIG. 72.]

Lupinus pallidus Brandegee, Zoe **4**: 203. 1893.

Differs from var. *Agardhianus* in having the pubescence mainly appressed, though with some spreading hairs; petals usually white or pale bluish; leaflets five or six, spatulate, rounded at apex: seeds "white marbled with black" or light tan spotted with darker tan.

CALIFORNIA. San Diego County: Mountain Springs, April, 1889, *C. R. Orcutt* (US) ; same locality, May, 1894, *L. Schoemfeldt, Int. Bound. Comm. 3065* (US); San Diego, May, 1906, *T. S. Brandegee* (B); San Filipe, April, 1895, *T. S. Brandegee* (UC); Sea Beach, April, 1882, *C. G. Pringle* (T,US); Tia Juana, May, 1903, *L. R. Abrams 3487* (DS, NY).

FIG. 72. LUPINUS CONCINNUS PALLIDUS (Brandegee) C. P. Smith. 1. *C. R. Orcutt 1326* (US); 2. *C. R. Orcutt* (US 21035); 3. *L. Schoemfeldt, I.B.C. 3065* (US)

LOWER CALIFORNIA. San Vincente, June, 1893, *T. S. Brandegee* (US); northern Lower California, April, 1886, *C. R. Orcutt 1326* (T, US).

2f. **Lupinus concinnus desertorum** (Heller) comb. nov. [FIG. 73.]

Lupinus desertorum Heller, Muhlenbergia **2**: 72. 1905.

Differs from var. *pallidus* in the number and shape of the leaflets which are six to nine, oblong-lanceolate, angled at apex.

CALIFORNIA. Kern County: Randsburg, April, 1905, *A. A. Heller 7679* (B; DS, UC, US). San Bernardino County: Ord Mountains, May, 1906, *Hall & Chandler 6792* in part* (B, UC).

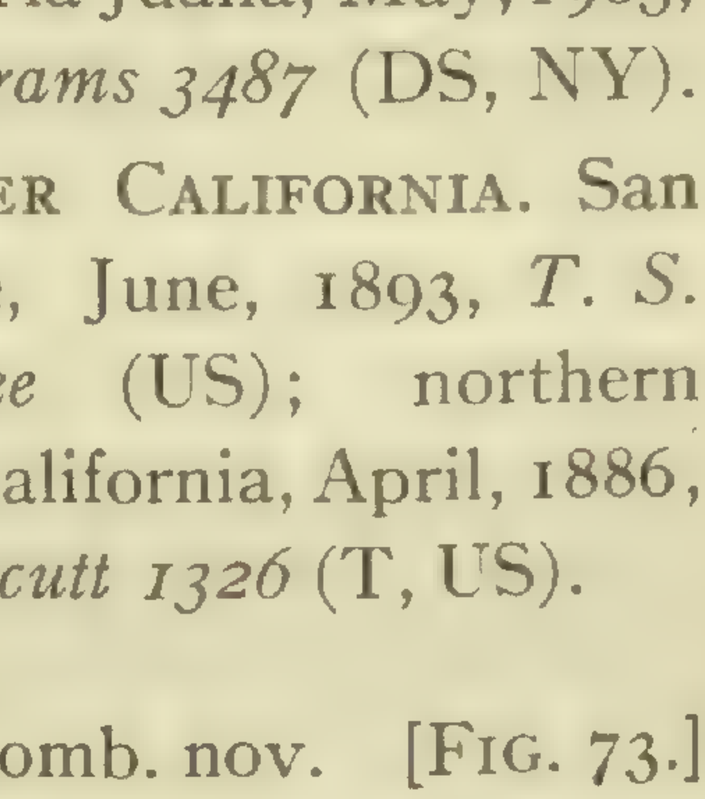

FIG. 73. LUPINUS CONCINNUS DESERTORUM (Heller) C. P. Smith. *A. A. Heller*.

SUBCARNOSI

3. LUPINUS SUBCARNOSUS Hook. Bot. Mag. **10**: *pl. 3467*. 1836. [FIG. 74.]

Lupinus texensis Hook. *Ibid*. **10**: *pl. 3492*. 1836.

Lupinus bimaculatus Hook.; Don, Sweet's Brit. Fl. Gard. II. **4**: *pl. 314*. 1838.

* The other specimen on this sheet is cited as typical *L. concinnus*.

Lupinus subramosus Hort.; Vilm. Fl. Pl. Terre 1: 479. 1865.

Lupinus leonensis Wats. Proc. Am. Acad. 17: 338. 1882.

Annual, biennial, or perhaps sometimes perennial, mostly branched at the base, the branches more or less decumbent, the whole plant 1.5–4 dm. tall, subappressed-silky pubescent, often with some spreading hairs; leaves several, very silky below and on the margins, glabrous or nearly so above, petioles fully twice as long as their longest leaflets, leaflets usually five only, oblanceolate, apex acute or obtuse, the lower leaves sometimes with more fleshy obovate leaflets, 12–25 mm. long, 6–12 mm. wide; peduncles 3–8 cm. long, racemes 6–12 cm. long, several-flowered; bracts 5–6 mm. long, lanceolate, deciduous; flowers 10–13 mm. long, spreading, approximate, non-verticillate, pedicels 3–6 mm. long; calyx bracteolate, the bractlets often over 2 mm. long and 1 mm. wide, upper lid bifid, 4–5 mm. long, lower lip entire or acutely three-toothed, about 6 mm. long; petals broad, bright blue, the banner with a white center which may turn purplish with age, suborbicular, 11–13 mm. long, 9–13 mm. wide, wings 10–11 mm. long, 6–7 mm. wide, keel non-ciliate, the usually slender point sharply upturned; pods silky, 25–35 mm. long, 6–8 mm. broad, stout and somewhat constricted between the large seeds, ovules four or five; seeds gray or tawny, unmarked or obscurely spotted, about 5 mm. long by 4 mm. wide, the hilum deeply sunken in a conspicuously projecting ring.

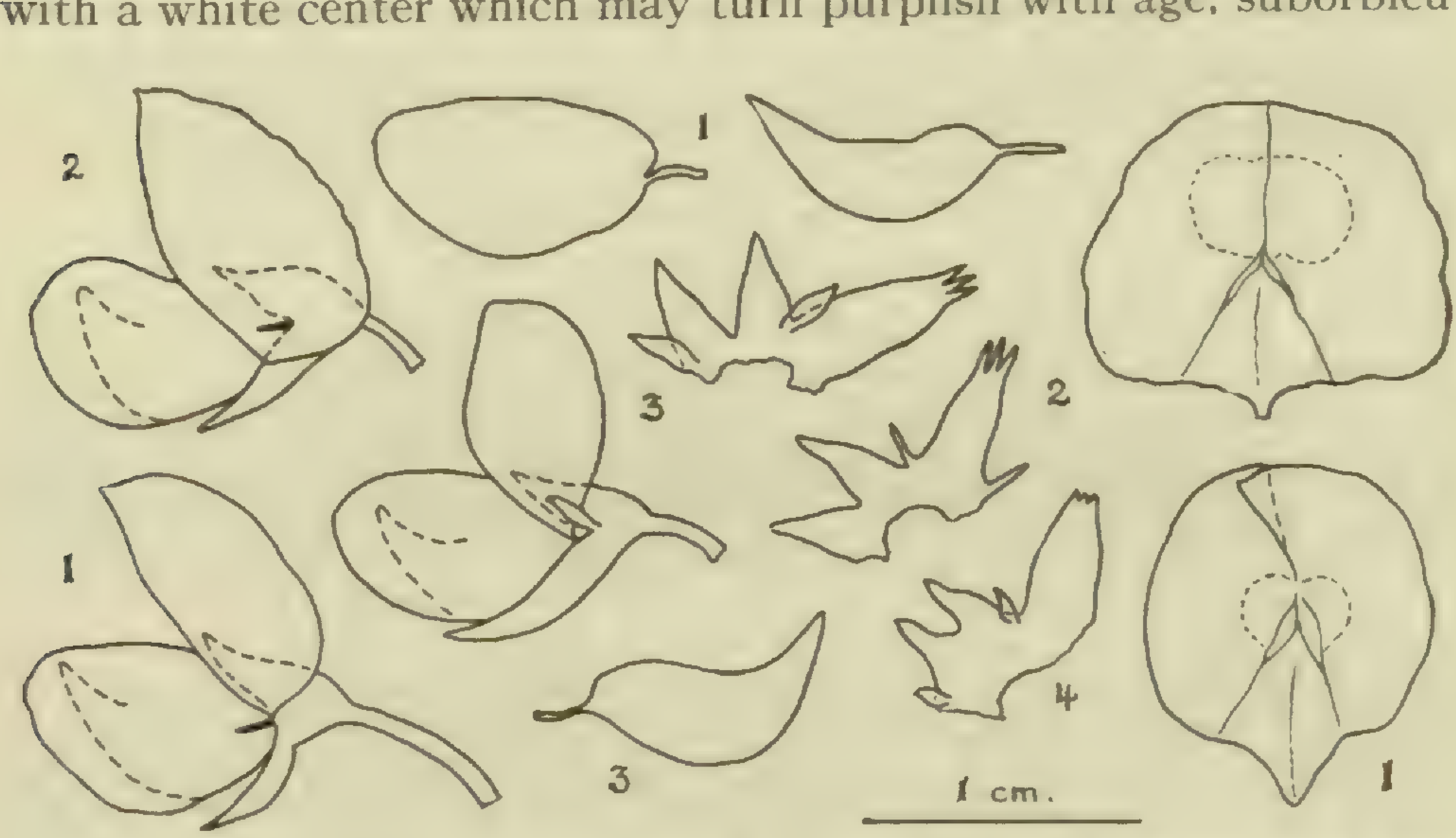

FIG. 74. LUPINUS SUBCARNOSUS Hook. 1. *F. L. Lewton 75* (US); 2. *A. Ruth 344* (US); 3. *E. Palmer 198* (G); 4. *C. G. Pringle 8297* (US).

This is another variable species, the extremes examined by Hooker appealing to him as distinct forms, although he must

have hesitated about publishing his third name. It was my earlier intention to account for these forms and maintain their names in a varietal classification; but when I carefully considered the array of specimens listed below, I was forced to the conclusion that the distinctions emphasized are not constant enough to permit such a treatment. *L. bimaculatus*, although said to be a perennial, and *L. subramosus*, although credited with leaflets oval and seven to nine in number, need to be checked up carefully before being recognized as good varieties; while the Gray Herbarium specimen of the type collection of *L. leonensis* does not permit me to separate same from the common *L. texensis* extreme. Extracts from the five descriptions follow:

L. subcarnosus. Herbaceus annuus, caule pubescenti-sericeo, foliolis quinis obovato-lanceolatis subcarnosis supra glaberrimis subtus (margineque praecipue) sericeis, stipulis elongato-subulatis, racemo pyramidali, pedicellis alternis longitudine florum, calycibus sericeis bibractiatis, labio superiore breviore bifido inferiore lanceolato apice tridentato dento intermedio longiore, vexillo orbiculari intense caeruleo medio macula alba plica longitudinali divisa.

A . . . very distinct species . . . specimens . . . in my Herbarium . . were collected at Bejar in Texas, by M. Berendier in 1828. It has been again gathered . . . by Mr. Drummond, between Brazoria and San Felipe . . . Seeds arrived in England from the last mentioned Naturalist, and have produced their handsome flowers in July of the present year, 1835. . . . keel white, much acuminated, purple-black at the tip. Legumes, in my native specimens, an inch and a half in length. linear-oblong, compressed. . . . 4 or 5 seeds . . . silky.

Hooker's second species is described with almost exactly the same words as the first; hence only the differences indicated are quoted here:

L. texensis. . . . foliolis . . . lanceolatis acutiusculis . . . stipulis subulatis . . . calycibus . . . bilabiatis utrinque bractea parva . . . inferiore acuminato integerrimo . . .

Much and closely as this plant resembles the *Lupinus subcarnosus* . . . it nevertheless appears to me to be really distinct. The habit is stouter, the leaves are by no means fleshy, nor are their leaflets retuse, but acute. . . . The lower lip of the calyx I find to be always entire . . . the former [*L. subcarnosus*] is found near the coast, the latter at San Felipe in the Interior. . . . The chief distinction is, however, certainly to be looked for in the foliage.

Lupinus bimaculatus. Hooker Mss. Root perennial. Stems . . . with adpressed silky hairs. . . . Leaves . . . quinate, leaflets oblong-spathulate . . . silky beneath, glabrous and pale green above, 1½ inches long. . . . Calyx silky, . . . appendiculate; upper-lip cloven . . . lower . . . ovate-lanceolate, acute, entire, keele . Vex. orbicular, slightly emarginate, blue, marked in the centre with a large pale, yellow spot which . . . changes to a dull red. . . . keel glabrous and white, with a dark blue elongated pointed incurved apex. Pod cylindrical, copiously silky, about an inch long, and having 3–5 seeds.

A very pretty perennial Lupine from Texas, a province of the Mexican republic, where it was discovered by the late Mr. Thos. Drummond, and introduced to our gardens from seed. . . .

L. subramosus. Texas. Annuel. Plante couverte de poils soyeux, mous et argentés. Tiges rameuses, dressées, hautes de 40 cent. environ. . . . folioles ovales

7–9, obscurement mucronulées . . . étendard d un beau bleu, marqué d une tache purpurine au centre ailes également bleues; carène blanche, á sommet bleu foncé. Dans les jeunes eurs, la tache de la carène est jaune paille p intillé de rouge. Graine petite, à peu pris carrée, à angles arrondis, à ombilic saillant sur l'un des coins . . .

L. leonensis. Biennial (?), branching at the base and the leafy stems decumbent (6 to 12 inches high), coarsely villous throughout, the hairs appressed or somewhat spreading . . . leaflet 5, oblanceolate, acute, very silky below and on the margins, glabrous or nearly so above, 6 to 10 lines long or less . . . flowers blue, 5 lines long, scattered . . . calyx tube turbinate . . . pods linear, 4 6-seeded, 12–15 lines long by 3 broad.

At Guajuco, Nuevo Leon (198). [E. Palmer.]

The above quotations will probably convince any student that the five names concerned belong to very closely related forms. Watson (Bib. Index 241. 1878) recognized the identity of Hooker's three species but seems to have forgotten these variations when he came to treat Palmer's collections from Northern Mexico. Hemsley (Biol. Cent. Amer. 1: 229. 1880) records *L. bimaculatus* from "Toluca, in alpine meadows, 12000 feet." As this is in the State of Mexico, it might well be expected that this will prove to be a distinct variety if not a separate species.

TEXAS. Austin County: Industry, 1893, *H. Wurzlow 18* (US), Bexar County: San Antonio, April, 1853, *G. Thurber* (G); same locality, March, 1881, *V. Havard 176* (G); same locality, *G. Jermy* (US); same locality, Alamo Heights, May, 1900, *R. N. Larrabee* (US). Blanco County: Cypress, 1905, *Mrs. M. Snyder* (UC). Comal County: Bracken, July, 1903, *B. H. A. Groth 219* (G). Comanche County: Commanche Spring, New Braunfels, etc., March, 1850, *F. Lindheimer 771* (G, NY, UC, US). Dallas County: Dallas, May, 1879, and April, 1880, *J. Reverchon* (G, UC. US): same locality, April, 1900, *B. F. Bush 585* (G, US). Dewitt County: Cuero, March, 1907, *A. H. Howell 300* (US). Gilespie County: Crab Apple, *G. Jermy 257* (US); Otto Mountain, *G. Jermy 256* (US). Harris County: Harrisburg, May, 1876, *J. F. Joor 58* (US). Kinney County: Fort Clark, March, 1893, *E. A. Mearns, Int. Bound. Comm. 1301* (DS, G, UC, US). Lavaca. County: Hallettsville, April, 1913, *J. Davis* (US); same, *A. E, Townsend* (US). Nueces County: Corpus Cristi Bay, March, 1894, *A. A. Heller 1466* (G, RM, UC, US); Corpus Cristi, April, 1905, *S. M. Tracy 9080* (G, NY, US); Nuecestown, April, 1896 *C. L. Marlatt* (US). Tom Green County: Dove Creek, May, 1880,

F. Tweedy 59 (US). Torrent County: Polytechnic, *A. Ruth 344* (US). Travis County: Austin, March, 1890, *J. E. Bodin 90* (US). Victoria County: Victoria, March, 1905, *F. L. Lewton 75* (US); same, April, 1907, *A. H. Howell 348* (US). Waller County: Hempstead, April, 1872, *E. Hall 159* (NY, US). County not determined: Rio Grande Prairies, 1844, *E. Meyer* (T); 1847–1848, *F. Lindheimer 600* (G, US); *C. Wright* (G, G); 1879, *J. Reverchon* (G); sheets 375 and 1555 from Berlander's herbarium (G); *A. M. Hildebrand* (US); *T. Drummond* (T, T); 1856, *Dr. Swift* (US).

NUEVO LEON. Guajuco, twenty-five miles southeast of Monterey, March, 1880, *E. Palmer 198* (G); Monterey foothills, March–April, 1906, *C. G. Pringle 10163* (G, NY, US); Monterey fields, March, 1891, *C. K. Dodge* 43 (US).

COAHUILA. Diaz, April, 1900, *C. G. Pringle 8297* (G, RM, UC, US).

The abbreviations herein used in the citation of specimens may be identified by reference to the following list:

B, Brooklyn Botanic Garden;
CPS, private herbarium of the writer;
DS, Dudley Herbarium of Stanford University;
G, Gray Herbarium of Harvard University;
NY, New York Botanical Garden;
RM, Rocky Mountain Herbarium, University of Wyoming;
T, Torrey Herbarium (at New York Botanical Garden);
UC, University of California;
US, United States National Herbarium.

My thanks are most cordially extended to the various friends who have so kindly assisted in this work by making it possible for me to examine the many specimens cited in the present paper and also those cited in the fourth and fifth papers of this series.

INDEX TO AMERICAN BOTANICAL LITERATURE

1916–1921

The aim of this Index is to include all current botanical literature written by Americans, published in America, or based upon American material; the word America being used in the broadest sense.

Reviews, and papers that relate exclusively to forestry, agriculture, horticulture, manufactured products of vegetable origin, or laboratory methods are not included, and no attempt is made to index the literature of bacteriology. An occasional exception is made in favor of some paper appearing in an American periodical which is devoted wholly to botany. Reprints are not mentioned unless they differ from the original in some important particular. If users of the Index will call the attention of the editor to errors or omissions, their kindness will be appreciated.

This Index is reprinted monthly on cards, and furnished in this form to subscribers at the rate of three cents for each card. Selection of cards is not permitted: each subscriber must take all cards published during the term of his subscription. Correspondence relating to the card issue should be addressed to the Treasurer of the Torrey Botanical Club.

Adams, J. F. Notes on plant diseases in Pennsylvania for 1916. Ann. Rep. Pennsylvania State Coll. **1916–17**: 329–336. *f. 2–12.* 1919.

André, H. Über die Ursachen des periodischen Dickenwachstums des Stammes. Zeitschr. Bot. **12**: 177–218. *pl. 3, 4 + f. 1.* 1920.
Among plants studied are species of *Nicotiana* and *Lantana.*

Arthur, J. C. New combinations for phanerogamic names. Torreya **21**: 11, 12. F 1921.
9 combinations in various genera.

Arthur, J. C. Origin of potato rust. Science II. **53**: 228, 229. 11 Mr 1921.

Beauverd, G. Un nouveau *Mitracarpus* de l'Uruguay. Bull. Soc. Bot. Genève II. **12**: 14, 15. 31 Ja 1921.

Bequaert, J. On the dispersal by flies of the spores of certain mosses of the family Splachnaceae. Bryologist **24**: 1–4. 22 Mr 1921.

Bergman, H. F. The effect of cloudiness on the oxygen content of water and its significance in cranberry culture. Am. Jour. Bot. **8**: 50–58. *f. 1–3.* 9 Mr 1921.

Bibb, L. B. Summation of dissimilar stimuli applied to leaflets of sensitive brier (*Schrankia*). Jour. Gen. Physiol. **3**: 523–526. *f. 1–3*. 20 Mr 1921.

Blake, S. F. *Neomillspaughia*, a new genus of Polygonaceae, with remarks on related genera. Bull. Torrey Club **48**: 77–88. *pl. 1*. 8 Mr 1921.

[**Blakeslee, A. F.**] Inheritance of germinal peculiarities.—*Portulaca*, *Datura*. Carnegie Inst. Washington Year Book **19**: 130–132. 3 F 1921.

Bödeker, F. Die Blüte der *Mamillaria De Laetiana* Quehl. Monatsschr. Kakteenk. **27**: 21. Ja 1917.

Bödeker, F. Weitere Beobachtungen, Erfahrungen und Ansichten. Monatsschr. Kakteenk. **26**: 145–150. O 1916.

Discussion of the identity of various Cactaceae.

Bödeker, F. Nochmals weitere Beobachtungen, Erfahrungen und Ansichten. Monatsschr. Kakteenk. **27**: 1–6. Ja 1917. [Illust.]

Further discussion of various species of Cactaceae.

Britten, J. Thomas Walter (1740–88) and his grass. Jour. Bot. **59**: 69–75. Mr 1921.

Britton, E. G. The preservation of our native plants. Jour. New York Bot. Gard. **22**: 40–44. F 1921.

Brooks, M. M. Comparative studies on respiration, XV. The effect of bile salts and of saponin upon respiration. Jour. Gen. Physiol. **3**: 527–532. *f. 1–3*. 20 Mr 1921.

Brown, J. P. *Catalpa speciosa* in den Vereinigten Staaten von Nordamerika. Mitt. Deutsch. Dend. Ges. **1920**: 80–95. *pl. 17–20*. 1920.

Compiled and brought together by A. Steffer.

Buchholz, M. Über die Wasserleitungsbahnen in den interkalaren Wachstumszonen monokotyler Sprosse. Flora **114**: 119–186. 1920.

Among plants studied is *Tradescantia virginica*.

Cannon, W. A. Effect of a diminished oxygen supply in the soil on the rate of the growth of roots. Carnegie Inst. Washington Year Book **19**: 59–61. 3 F 1921.

Cannon, W. A. Some structural features of the chlorophyll-bearing organs of perennials of South Australia. Carnegie Inst. Washington Year Book **19**: 80, 81. 3 F 1921.

Cannon, W. A., & Free, E. E. Anaerobic experiments with helium. Carnegie Inst. Washington Year Book **19**: 61, 62. 3 F 1921.

Cannon, W. A., & Free, E. E. Root adaptation to deficient soil aeration. Carnegie Inst. Washington Year Book **19**: 62. 3 F 1921.

Chambers, W. H. Studies in the physiology of the fungi.—XI. Bacterial inhibition by metabolic products. Ann. Missouri Bot. Gard. **7**: 249–289. *f. 1–11.* N 1920.

Chancerel, L. Flore forestiere du globe. Pp. 1–738. Paris. 1920.

Chase, A. The Linnaean concept of pearl millet. Am. Jour. Bot. **8**: 41–49. 9 Mr 1921.

Chase, A. The North American species of *Pennisetum*. Contrib. U. S. Nat. Herb. **22**: 209–234. *f. 63–76.* 1921.
Includes *P. prolificum*, sp. nov., from Mexico.

Chodat, R. Sur un nouveau *Cneorum*, le *Cneorum trimerum* (Urb.) Chod. Bull. Soc. Bot. Genève II. **12**: 23, 24. 31 Ja 1921.
Based upon *Cubincola trimera* Urb., of Cuba.

Christensen, C., & Skottsberg, C. The ferns of Easter Island. Nat. Hist. Juan Fernandez & Easter Isl. **2**: 47–53. *f. 1–3.* 1920.
Includes *Doodia paschalis*, sp. nov.

Christensen, C., & Skottsberg, C. The Pteridophyta of the Juan Fernandez Islands. Nat. Hist. Juan Fernandez & Easter Isl. **2**: 1–46. *pl. 1–5* + *f. 1–7.* 1920.
Includes new species in *Trichomanes* (1), *Hymenophyllum* (1), and *Ophioglossum* (1).

Church, A. H. The somatic organization of the Phaeophyceae. Bot. Mem. Oxford **10**: 1–110. 1920.

Clements, F. E. Adaptation and mutation as a result of fire. Carnegie Inst. Washington Year Book **19**: 348, 349. 3 F 1921.

Clements, F. E. Biotic succession in Bad Lands. Carnegie Inst. Washington Year Book **19**: 362, 363. 3 F 1921.

Clements, F. E. Climax formations. Carnegie Inst. Washington Year Book **19**: 350. 3 F 1921.

Clements, F. E. Indicator plants. Carnegie Inst. Washington Year Book **19**: 363, 364. 3 F 1921.

Clements, F. E. & E. S. Changes in vegetation. Carnegie Inst. Washington Year Book **19**: 351–353. 3 F 1921.

Clements, F. E., E. S., & Loftfield, G. V. Periodicity of vegetation. Carnegie Inst. Washington Year Book **19**: 354, 355. 3 F 1921.

Clements, F. E., E. S., & Loftfield, G. V. Permanent quadrats. Carnegie Inst. Washington Year Book **19**: 359, 360. 3 F 1921.

Clements, F. E., & Douglass, A. E. Climatic cycles. Carnegie Inst. Washington Year Book **19**: 358, 359. 3 F 1921.
Study of *Sequoia*.

Clements, F. E., & Hall, H. M. Experimental taxonomy. Carnegie Inst. Washington Year Book **19**: 345, 346. 3 F 1921.
Observations of transplanted species.

Clements, F. E., & Hall, H. M. Taxonomic monographs. Carnegie Inst. Washington Year Book **19**: 346, 347. 3 F 1921.
Reports very briefly studies on *Artemisia*, *Chrysothamnus*, *Haplopappus* and *Atriplex*.

Clements, F. E., & Long, F. Experimental pollination. Carnegie Inst. Washington Year Book **19**: 349. 3 F 1921

Clements, F. E., & Long, F. Photosynthetic efficiency. Carnegie Inst. Washington Year Book **19**: 344, 345. 3 F 1921.

Clements, F. E., & Weaver, J. E. Transplant quadrats and areas. Carnegie Inst. Washington Year Book **19**: 355–357. 3 F 1921.

Clute, W. N. Botanizing in the Painted Desert [Arizona]. Am. Bot. **27**: 1–8. F 1921. [Illust.]

Clute, W. N. Plant partnerships. Gard. Chron. Am. **25**: 502, 503. Mr 1921.

Coker, W. C. Notes on the Thelephoraceae of North Carolina. Jour. Elisha Mitchell Sci. Soc. **36**: 146–196. *pl. 14–35*. F 1921.
Includes 1 new species in *Aleurodiscus*.

Collins, J. F. Three plants new to Rhode Island. Rhodora **23**: 27. 8 Mr 1921.

Cooper, W. S. Ecology of the strand vegetation of the Pacific Coast of North America. Carnegie Inst. Washington Year Book **19**: 79, 80. 3 F 1921.

Cunningham, B. A pure culture method for diatoms. Jour. Elisha Mitchell Sci. Soc. **36**: 123–126. *pl. 9*. F 1921.

Cunningham, B. The occurrence of unlike ends of the cells of a single filament of *Spirogyra*. Jour. Elisha Mitchell Sci. Soc. **36**: 127, 128. *pl. 10*. F 1921.

Dahlgren, K. V. Zur Embryologie der Kompositen mit besonderer Berücksichtigung der Endospermbildung. Zeitschr. Bot. **12**: 481–516. *f. 1–56*. 1920.
Studied many Old World and American species.

Duggar, B. M. Salt requirements of seed plants. Carnegie Inst. Washington Year Book **19**: 66–68. 3 F 1921.

Duggar, B. M. The nutritive value of the food reserve in cotyledons. Ann. Missouri Bot. Gard. **7**: 291–298. *pl. 7* + *f. 1*. N 1920.

Duggar, B. M. The use of "insoluble" salts in balanced solutions for seed plants. Ann. Missouri Bot. Gard. **7**: 307–327. *f. 1–4*. N 1920.

Dutton, D. L. *Buxbaumia indusiata* Brid., from Brandon, Vermont. Bryologist **24**: 8. 22 Mr 1921.

East, E. M., & Jones, D. F. Genetic studies on the protein content of maize. Genetics **5**: 543–610. *f. 1–8.* N 1920.

Edgerton, C. W., & Moreland, C. C. Eggplant blight. Louisiana Agr. Exp. Sta. Bull. 178: 1–44. *f. 1–18.* Ja 1921.

Fernald, M. L. The North American representatives of *Scirpus cespitosus.* Rhodora **23**: 22–25. 8 Mr 1921.

Includes *Scirpus cespitosus* var. *delicatulus* var. nov. from Newfoundland and Maine.

Fischer, J. Zur Entwicklungsgeschichte und Morphologie der Veronicablüte. Zeitschr. Bot. **12**: 113–161. *f. 1–23.* 1920.

Fries, R. E. Die Myxomyceten der Juan Fernandez Inseln. Nat. Hist. Juan Fernandez & Easter Isl. **2**: 55–58. 1920.

Frye, T. C. Plant migration along a partly drained lake. Publ. Puget Sound Biol. Sta. **2**: 393–397. 30 D 1920.

Gericke, W. F. Influence of temperature on the relations between nutrient salt proportions and the early growth of wheat. Am. Jour. Bot. **8**: 59–62. 19 Mr 1921.

Grier, N. M. Notes on *Hemerocallis*, II. Torreya **21**: 12, 13. F 1921.

Gundersen, A. Plant families: a plea for an international sequence. New Phytol. **19**: 264–271. 31 Ja 1921.

Haan, H. R. M. de. Contribution to the knowledge of the morphological value and the phylogeny of the ovule and its integuments. Recueil Trav. Bot. Néerlandais **17**: 219–324. 1920.

Hall, H. M. Statistical studies. Carnegie Inst. Washington Year Book **19**: 348. 3 F 1921.

Studied *Artemisia* and *Chrysothamnus.*

Hall, H. M. Taxonomy of the Madieae. Carnegie Inst. Washington Year Book **19**: 347. 3 F 1921.

Notes progress of work.

Hall, H. M., & Long, F. Rubber plants. Carnegie Inst. Washington Year Book **19**: 365, 366. 3 F 1921.

Hansen, A. A. Our disappearing wild plants. Science II. **53**: 178–180. 25 F 1921.

Discusses flora of District of Columbia.

Hansen, A. A. Recent Pennsylvania weeds. Ann. Rep. Pennsylvania State Coll. **1916–17**: 317–328. 1919. [Illust.]

Harms, H. Über einige brasilianische *Lupinus*-Arten mit einfachen Blättern. Repert. Spec. Nov. Regn. Veg. **17**: 4, 5. 1 Ja 1921.
Includes *L. Sellowianus*, sp. nov.

Harris, J. A. Studies on the physico-chemical properties of vegetable saps. Carnegie Inst. Washington Year Book **19**: 142, 143. 3 F 1921.

Harris, J. A., Sinnott, E. W., Pennypacker, J. Y., & Durham, G. B. The vascular anatomy of dimerous and trimerous seedlings of *Phaseolus vulgaris*. Am. Jour. Bot. **8**: 63–102. *f. 1–23*. 19 Mr 1921.

Harter, L. L. Amylase of *Rhizopus Tritici*, with a consideration of its secretion and action. Jour. Agr. Research **20**: 761–786. 15 F 1921.

Heimerl, A. Nyctaginaceae novae. Repert. Spec. Nov. Regn. Veg. **17**: 1–3. 1 Ja 1921.
Includes *Pisonia Broadwayana*, sp. nov., from Tobago.

Herzog, T. Die Bryophyten meiner zweiten Reise durch Bolivia. Nachtrag. Bibl. Bot. **88**: 1–31. *f. 1–19*. 1921.
Includes 26 new species.

Inman, O. L. Comparative studies on respiration.—XVI. Effects of hypotonic and hypertonic solutions upon respiration. Jour. Gen. Physiol. **3**: 533–537. *f. 1, 2*. 20 Mr 1921.

Jagger, I. C. A transmissible mosaic disease of lettuce. Jour. Agr. Research **20**: 737–740. *pl. 87*. 15 F 1921.

Kempton, J. H. A brachytic variation in maize. U. S. Dept. Agr. Farmers' Bull. 925: 1–28. *pl. 1–19* + *f. 1–8*. 18 F 1921.

Kidder, N. T. Additions to the flora of Isle au Haut [Maine]. Rhodora **23**: 26. 8 Mr 1921.

Kränzlin, F. Bignoniaceae novae. Repert. Spec. Nov. Regn. Veg. **17**: 18–22. 1 Ja 1921.
Includes 4 new American species of *Arrabidaea*.

Lee, H. A., & Scott, L. B. Are Valencia oranges from China? Jour. Hered. **11**: 329–333. *f. 20–22*. 23 Mr 1921.

Lemoine, [Mme. Paul]. Botanische Ergebnisse der schwedischen Expedition nach Patagonien und dem Feuerlande 1907–1909. VII. Les Melobésiées. Kungl. Svenska Vetensk. Handl. **6**[1], no. 4: 1–17. *pl. 1* + *f. 1, 2*. 1920.
Includes new species in *Lithothamnium* (2) and *Lithophyllum* (4).

Lendner, A. Un champignon parasite sur une Lauracée du genre *Ocotea*. Bull. Soc. Bot. Genève II. **12**: 122–128. *f. 1, 2*. 31 Ja 1921.
Cryptobasidium, gen. nov., from Costa Rica.

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BULLETIN

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TORREY BOTANICAL CLUB

SEPTEMBER, 1921

The air chambers of Reboulia hemisphaerica

(WITH TWENTY-TWO TEXT FIGURES)

A. W. DUPLER

INTRODUCTION

The air chambers of the Marchantiales may be grouped under the three categories outlined by Leitgeb (**12**, **13**, **14**). These categories, named after characteristic genera, were defined by him essentially as follows: 1, the *Riccia* type, with simple air chambers, the chlorophyll being in the wall cells; 2, the *Marchantia* type, in which the simple chambers contain filaments of chlorophyllose cells; and 3, the *Reboulia* type, in which the primary chambers are more or less divided into secondary chambers by plates of cells arising from the sides, floor and even roof of the primary chambers. While the *Reboulia* type of chamber has been studied in other genera, *Reboulia* itself has received very little attention.

HISTORICAL

In the literature dealing with the air chambers of the Marchantiales two general problems have arisen, so far as the *Reboulia* type is concerned. The first of these has to do with the question whether the subdivisions of the primary chambers are due to ingrowths into the primary chamber or arise as a result of schizogenous splitting of the thallus tissue. The second and more fundamental problem has to do with the origin and early development

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of the air chambers. In this connection two points of view have been emphasized, viz., that of Leitgeb (12, 13, 14), who regarded them as formed by a dorsal upgrowth arising from superficial cells, and that of Barnes and Land (1), who pointed out the internal schizogenous origin of the air chambers. A summary of the earlier literature dealing with this problem, dating back to Hofmeister (11), is to be found in the paper by Barnes and Land; while the later literature has been reviewed by Evans (7). In the present paper reference is made to the recent literature only when it bears somewhat directly on *Reboulia* itself or its close allies.

Leitgeb's interpretation of the structure and partitioning of the air chambers of *Reboulia*, as noted above, has been generally accepted by such writers as Cavers (4, 5), Campbell (3), and Goebel (8). Cavers notes that near the apex there is but a single layer of chambers, each with a simple pore, but that the chambers become partitioned as they develop. Campbell holds for *Reboulia* and *Fimbriaria* (*F. californica* is especially described) that there is a more or less complete division of the primary chambers by the formation of diaphragms. Barnes and Land (1) state that in *Plagiochasma* it appears probable that the partitioning of the chambers occurs as described by Leitgeb but that "the formation of the aerating tissue is mainly due to splitting and growth." From her study of *Plagiochasma* (*Aytonia*) Miss Starr (16) claims that Leitgeb's partitioning plates are not outgrowths but arise by "stretching and tearing of tissues between neighboring chambers . . . the tearing being due to the differences in tension between the upper and lower parts of the thallus. This leaves projecting plates of cells, appearing as filaments in section, which Leitgeb and Campbell interpreted as new growth dividing the original chambers. Perhaps these plates add to their length by further growth." Evans (7) has made a very careful study of the air chambers in *Grimaldia fragrans*, and his results are of importance in a comparison with *Reboulia*. He finds that the primary chambers of the dorsal region "are subdivided by an irregular system of more or less vertical, united cell plates, enclosing narrow spaces, so that the boundaries of the chambers are difficult to distinguish." He finds that these plates may end freely below the epidermis or extend to the epidermis but that "it is doubtful . . . if the connec-

tion is anything more than a close contact." He adds further, "no instance has been observed where an outgrowth extends downward from the epidermis and ends freely in a chamber, and there is no adequate evidence that the epidermal cells themselves ever give rise to outgrowths." He finds the "more deeply situated" chambers simple and usually without any partitioning cell plates. The secondary partitions apparently arise as outgrowths from the floor, as one would interpret the statement, "as the writer conceives the process, the growth of the partitions is both horizontal and vertical, the growth in the latter direction being often equalled by the upward growth (accompanied by cell division) of the cells forming the floors of the chambers; these in turn remain more or less united with one another and with the cells of the partitions and in this way form the system of united cell-plates in the dorsal chambers." In a study of the chambers of the female receptacle surface outgrowths from the partitions themselves are found, but "in the vegetative thallus such outgrowths evidently play a very minor part in the development of the green tissue." Evans concludes further that the increase in size of the chambers is due largely to the growth of the bounding cells, differing in this respect from Miss Starr in her interpretation of the situation in *Plagiochasma*. Haupt (**9**) describes the air chambers of *Reboulia* but does not consider the problem of the origin and development of the internal partitions.

With regard to the problem of the origin of the air chambers Leitgeb based his theory of the superficial origin by upgrowth on a study of the Ricciaceae (**12**) but later (**13**, **14**) applied it to the Marchantiaceae as well. His theory remained unquestioned for some time, even in view of his own admission that at least a part of the air chambers seemed to arise schizogenously in *Reboulia* and *Plagiochasma*. Barnes and Land (**1**) controverted Leitgeb's idea, replacing it by one which accounts for the origin of the air chambers in the Marchantiales as "arising invariably by the splitting of internal cell walls, usually at the junction of the outermost and first internal layer of cells." Of the forms with the *Reboulia* type of chamber they studied *Fimbriaria* (probably *F. echinella* Gottsche) and *Plagiochasma* sp., finding in the former that "the primary splitting usually begins between the cells

arising from successive segments. . . . Later, and often deep in the tissue, secondary splitting gives rise to intercellular spaces which may reach the surface or may break into a primary space. In *Plagiochasma* the situation is similar only the secondary splitting occurs more quickly and becomes quite extensive. The passages are not wide and shallow, but always deep and narrow open almost or quite uninterruptedly until the pore margin is well begun."

The problem thus opened up anew was attacked by different writers, dealing largely with the Ricciaceae and *Targionia*. Miss Hirsch (10) and Miss Black (2) both support the Leitgeb view for *Riccia Frostii*. Campbell (3) regards their work, as well as that of Miss O'Keefe (15), as showing that Leitgeb's account of the formation of air spaces in *Riccia glauca* and other allied species is entirely correct. Both Deutsch (6) and Miss O'Keefe (15), in their studies of *Targionia hypophylla*, agree that the chambers arise by splitting, but that the splitting begins superficially and proceeds inward, instead of arising internally and proceeding outward. Miss Starr's study of *Plagiochasma* (16) leads her to conclude that there is no doubt as to the internal schizogenous origin of the air chambers of both thallus and receptacle. The development of the barrel-shaped air-pore on the receptacle is described in detail. Evans (7) reviews the recent work on the problem pointing out that in all cases, even including the work of Miss Hirsch and Miss Black, the origin of the air chambers is probably due to splitting of the cell walls, although it may begin superficially in some cases. From his study of *Grimaldia fragrans* he concludes that "the chambers all owe their origin to a splitting of cell walls in closely united tissue. In the case of the dorsal chambers the split sometimes begins below the surface and extends outward, sometimes at the surface and extends inward." Further, "that there still seems to be no conclusive evidence that Leitgeb's explanation ever applies." Haupt (9) in his recent study of *Reboulia hemisphaerica* states that "the air chambers of *Reboulia* arise immediately behind the apical cell of the thallus by intercellular splittings which start at the surface of the thallus and progress inward, reaching the line of differentiation between the dorsal and ventral regions. Secondary splittings occur deep within the dorsal region and do not reach the surface." No

account of the development of the chambers of the receptacle is given by either Evans or Haupt for the two forms which they studied.

AIR CHAMBERS OF THE THALLUS

Mature features.—In such forms as *Marchantia* and *Conocephalum* surface markings indicate the internal chambers, but *Reboulia* and its allies have no such external markings, the upper

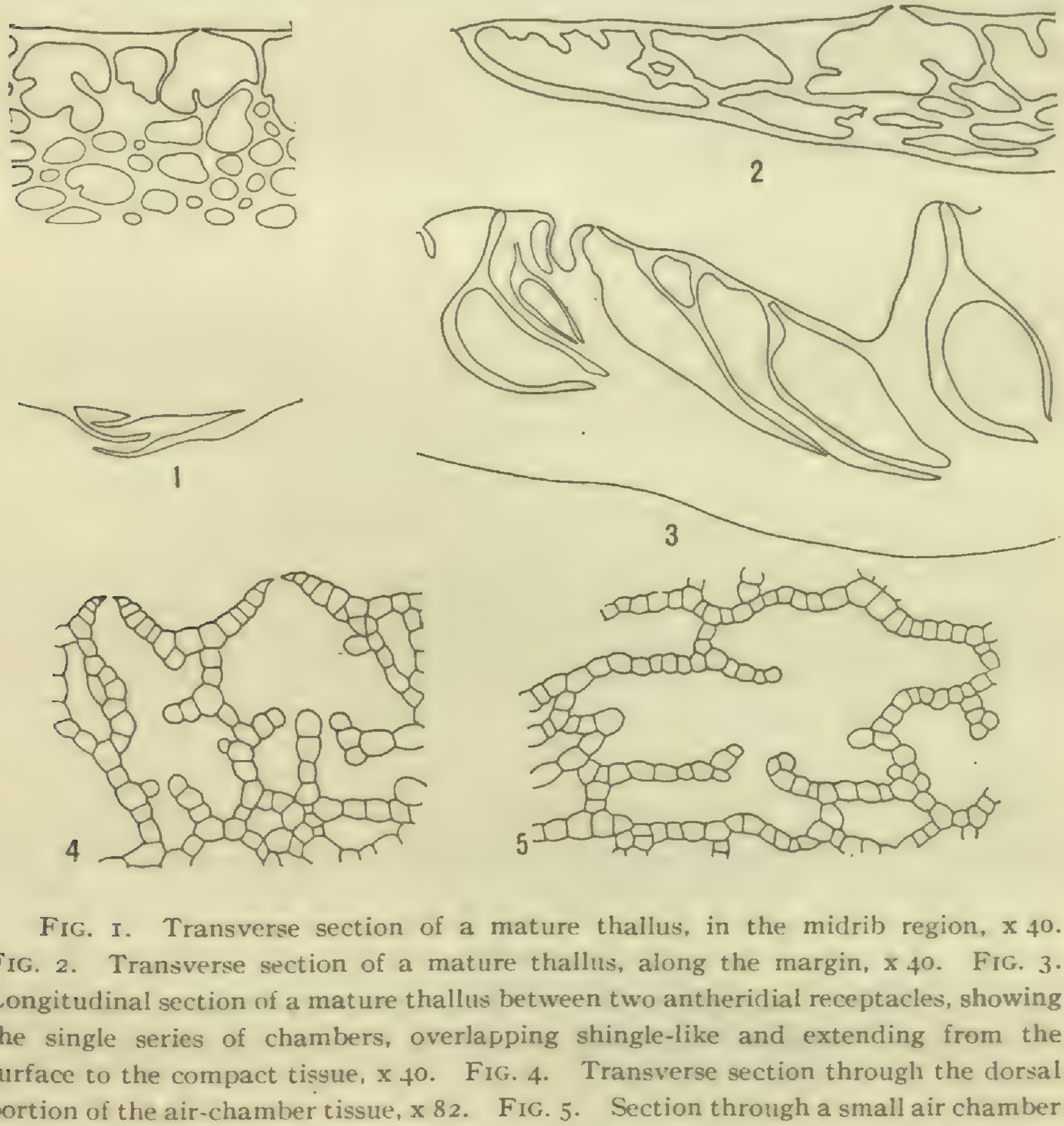

FIG. 1. Transverse section of a mature thallus, in the midrib region, x 40. FIG. 2. Transverse section of a mature thallus, along the margin, x 40. FIG. 3. Longitudinal section of a mature thallus between two antheridial receptacles, showing the single series of chambers, overlapping shingle-like and extending from the surface to the compact tissue, x 40. FIG. 4. Transverse section through the dorsal portion of the air-chamber tissue, x 82. FIG. 5. Section through a small air chamber cut parallel with the surface, x 82.

surface being uniform in color and smooth except for the very slight conical projections with air-pores in the center. Whole mounts of the thallus, stained *in toto*, show that the very elongated air chambers extend lengthwise along the midrib and from this

radiate pinnately toward the margin. The secondary partitions are for the most part parallel with or slightly oblique to the primary walls, and give a very areolated structure to the thallus, only the number and distribution of the air pores giving any indication as to the primary chambers. A cross section of the thallus in the midrib region shows several layers of superimposed chambers in this region (FIG. 1), the chambers being gradually reduced to a single layer along the margin (FIG. 2). The compact ventral tissue also gradually becomes narrower until at the margin of the thallus it is usually only a single layer of cells in thickness. Longitudinal sections (FIG. 3) show that this appearance of superimposed chambers is due largely, if indeed not altogether, to an extensive shingle-like overlapping of the primary chambers, greatly complicated by the formation of partial secondary chambers by partitions which form in the chambers. These primary chambers extend from the surface to the compact ventral tissue. Of course, "deeper" chambers appear in sections cut in almost any direction, but a careful study of these chambers through a complete series of sections shows them to be largely the more deeply situated portions of the primary chambers. Where the tissue is more compact, as in *Plagiochasma* and *Grimaldia fragrans*, the deep secondary chambers may be more probable. An examination of a few preparations of *Neesiella rupestris* indicates that the interpretation here applied to *Reboulia* also applies to that form, which has a more simply organized tissue than *Reboulia*. Cross sections give an appearance similar to that described for *Grimaldia* by Evans (7), the dorsal chambers being partially subdivided by plate-like outgrowths arising from the sides and floor of the chambers. Sections parallel to the surface are helpful in the interpretation of the structure (FIG. 5). It is very doubtful whether any plates arise from the roof of the chamber and project downwards into the chambers, the appearance of this in sections being due to the oblique inclination of the plates. Many of these secondary plates come in contact with the roof of the chambers. The primary partitions, the secondary plates and the roof of the chamber are all but a single layer of cells in thickness. Occasionally the cone formed by the air-pore projects inward into the chamber, this condition being associated with the portion of the thallus immediately posterior to the male receptacle.

Origin and development.—The young chambers evidently arise schizogenously, the splitting beginning as close to the apical cell as between the third and fourth segments (FIGS. 6, 8). The splitting probably begins internally (FIG. 7), although a superficial splitting is also initiated very soon, and the process apparently proceeds simultaneously from both these points, the two splits meeting about midway (FIGS. 6, 8). The turgor conditions which effect splitting can reasonably bring about external as well as internal separation. As the thallus thickens back of the apex the splitting may continue to deeper levels, although the increased

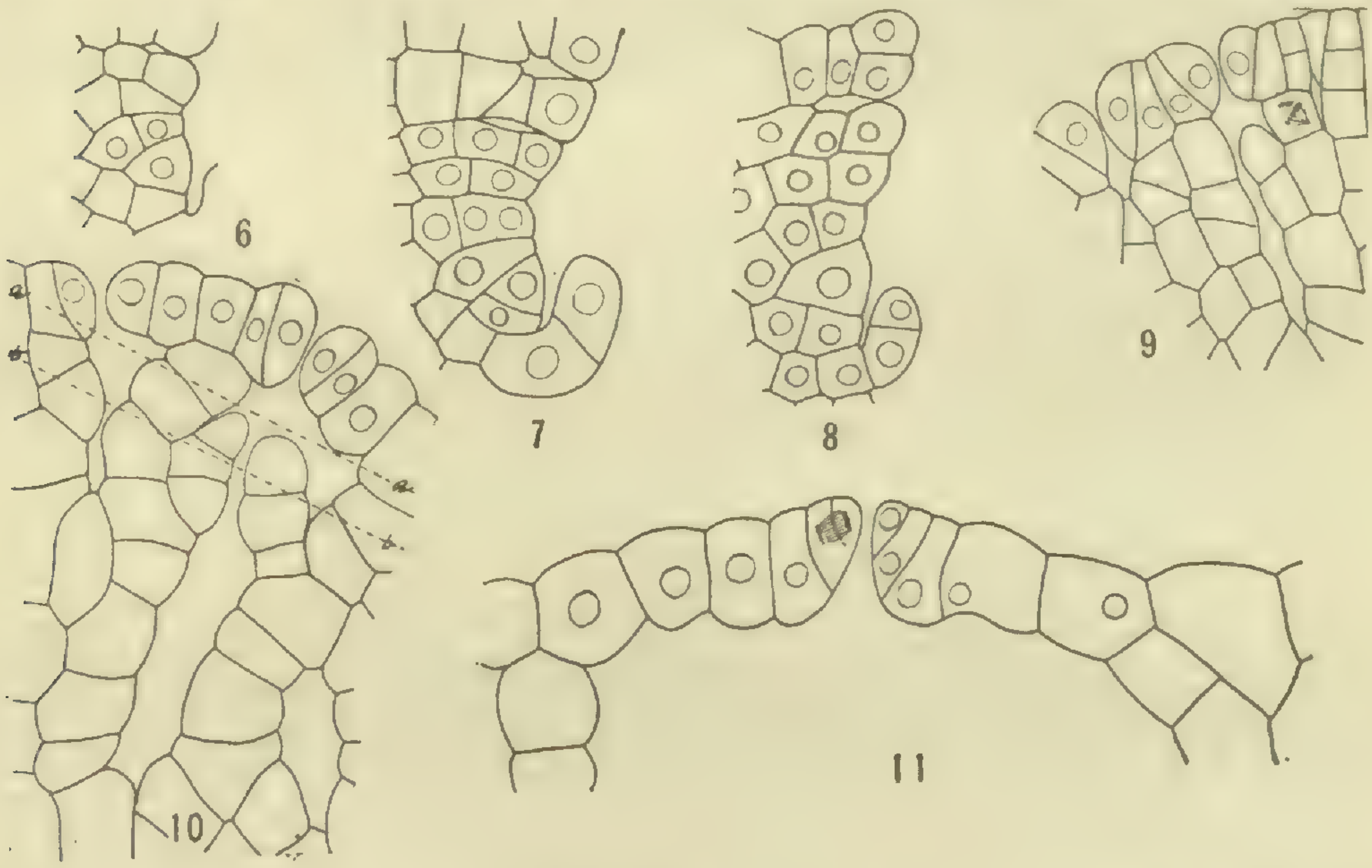

FIG. 6. Longitudinal section through a growing point, showing the apical cell and the beginning of an air chamber, with both internal and superficial splitting, x 433. FIG. 7. Similar section, showing air chamber with internal origin, x 433. FIG. 8. Similar section with slightly older air chamber, x 433. FIG. 9. Longitudinal section of young air chambers, showing beginning of secondary partitioning and intercalary division in the primary partition, x 433. FIG. 10. Air chamber a little older than that of FIG. 9, x 433. FIG. 11. Epidermis of a nearly mature chamber, x 433.

depth of the chambers is due in large part to intercalary growth of the partitions themselves (FIG. 14). The earliest chambers are horizontal but with the growth of the thallus become obliquely inclined. Early in the development of the chambers the secondary plates have their origin as lateral outgrowths from the primary partitions (FIGS. 9, 10). These are so situated in the narrow

chambers as to give the appearance in section (FIG. 10) of narrow passage ways between "dorsal" and "more deeply situated" chambers, though in fact but lateral outgrowths of the primary chambers. They arise at different levels and contribute to the complex network of the mature thallus. I find no indication of secondary splitting in the compact tissue. Chambers appearing as such are easily found, but when traced always show connections with the surface chambers. A section of FIG. 10 along the line *aa* would show a few large chambers. One at the level *bb* would show smaller but more numerous spaces between the cells, an appearance similar to that shown by Evans (7, *f. 11*, *12*) for *Grimaldia*. His *f. 13* of a longitudinal section of the same stage is essentially like that of FIG. 10 and would lend itself to the same interpretation as is here made for *Reboulia*.

The single superficial cell of the partition (FIG. 7) soon divides into segments, and a circle of triangular cells around the young pore is thus formed. These divide by oblique tangential walls (FIG. 9), forming the first circle of the actual air-pore cells. Continued divisions (FIGS. 10, 11) build up the series of concentric circles surrounding the simple pore.

THE FEMALE RECEPTACLE

At first the young female receptacle consists of a very compact tissue, air chambers not appearing until after the archegonia have started their development (FIGS. 12, 13). The first air chambers are formed at the crest of the young receptacle (FIG. 13) but with the growth of the latter appear nearer the archegonia (FIGS. 14, 15). The young chambers arise by internal splitting, but superficial splitting also begins very soon and the two proceed simultaneously just as in the thallus (FIGS. 13, 14). The internal split extends to a depth of but a few layers of cells (FIG. 16), increase in depth and diameter being due to intercalary growth of the partitions, which remain but one cell layer thick. The chambers become obliquely pyramidal (FIGS. 19, 21), with the apex pointing toward the center of the receptacle, and overlap one another at maturity, as in the case of the thallus only to a less extent. I found no indication of secondary deep splitting on the young receptacle and see no necessity for interpreting the mature struc-

ture as due to the occurrence of such splitting. Projecting into the primary chambers are cell plates, beginning while the chambers are yet quite small (FIG. 21) and becoming quite pronounced by the time of maturity.

A surface view of the young receptacles (FIG. 17) shows that young air chambers arise at most of the intersection points of the cells dorsal to the archegonia, the young pores being bounded originally by four or five cells which in vertical section appear papillate (FIG. 13). The primary bounding cells then divide by walls extending from pore to pore, forming a circle of wedge-shaped

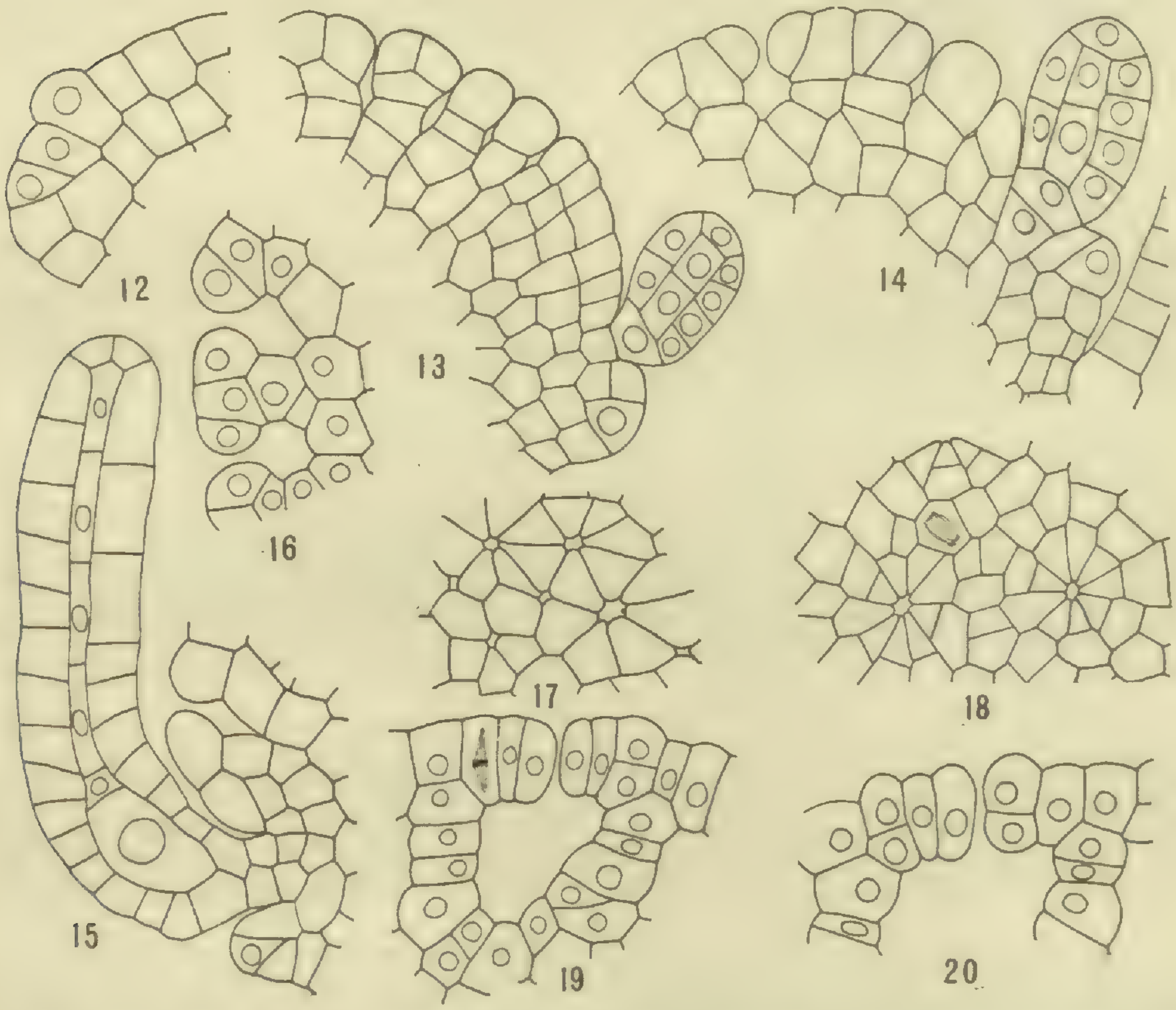

FIG. 12. Section through a young female receptacle, showing the apical cell and archegonium initial. At this stage there is no indication of air chamber formation, x 433. FIG. 13. Young receptacle showing oldest air chambers at the crest. The tissue near the archegonium is yet compact, x 433. FIG. 14. Air chambers more advanced than in FIG. 13, x 433. FIG. 15. Young air chamber immediately dorsal to the archegonium, x 433. FIG. 16. Air chambers nearer the crest of same receptacle as FIG. 15, x 433. FIG. 17. Surface view of young receptacle, showing beginning of air chambers, same stage as FIG. 13, x 433. FIG. 18. Surface view of older receptacle, x 433. FIG. 19. Vertical section of a young chamber, x 433. FIG. 20. Beginning of the barrel-pore of the female receptacle, x 433.

cells around the pore (FIG. 17). Divisions tangential to the pore begin the formation of the roof of the chamber, forming a circle of small wedge-shaped cells (FIG. 18). As development proceeds the chambers become wider (FIGS. 19–21), the growth of the roof keeping pace. At first the roof consists of but a single layer of cells, but very early in development periclinal divisions occur, usually beginning at the margins of the chamber (FIG. 19) and proceeding until the roof becomes, as a rule, two cells in thickness (FIG. 21). Very short outgrowths may project from the roof into the chamber.

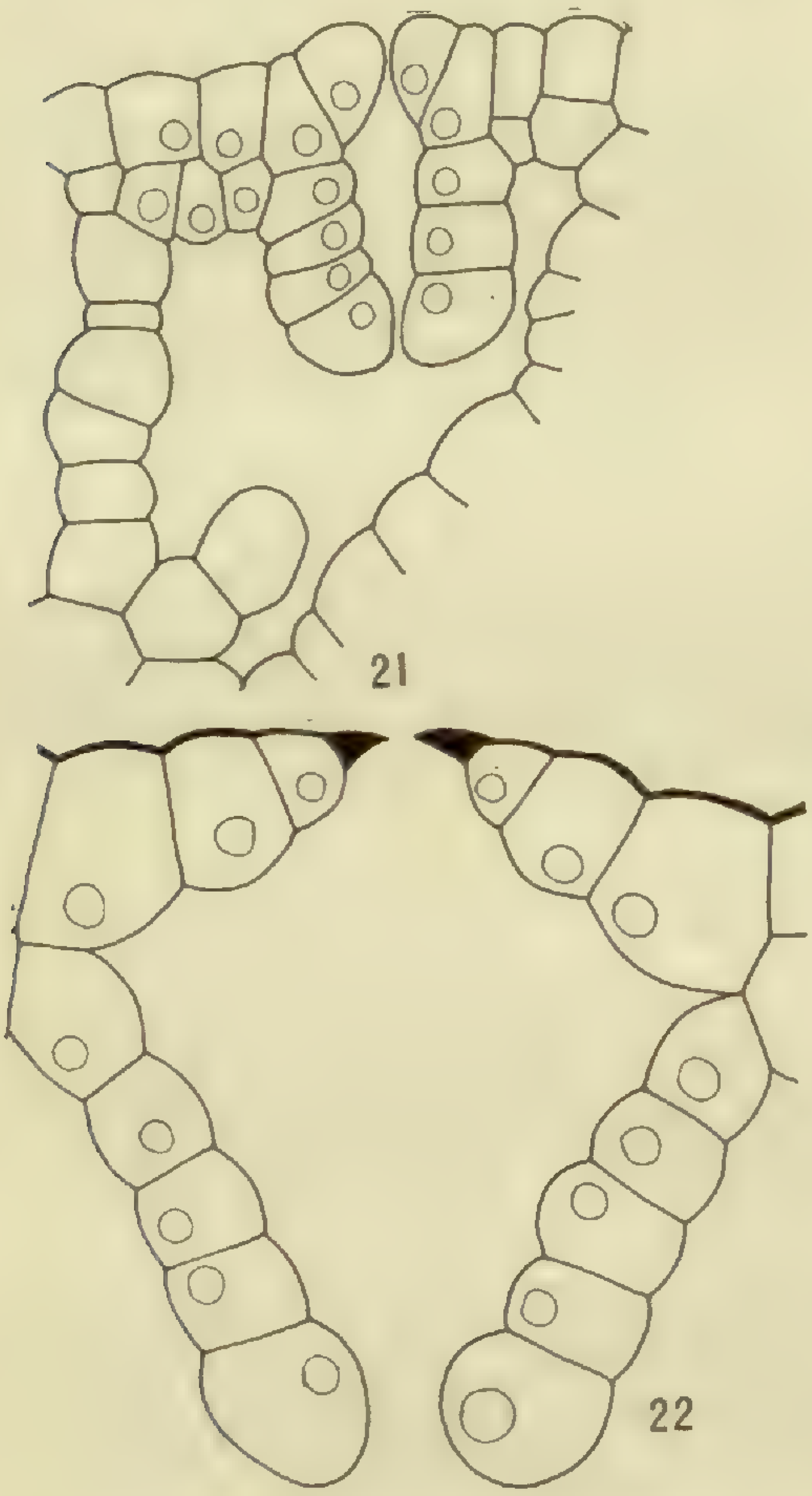

FIG. 21. Vertical section of a young chamber, showing the nearly complete barrel-pore and a secondary plate projecting into the chamber, x 433. FIG. 22. Mature pore on female receptacle, x 433.

In sharp contrast to the simple pores of the thallus are the large barrel-shaped pores of the female receptacle. Usually the young pore is open from the start, differing in this respect from the young pores of *Plagiochasma* as shown by Miss Starr (16). The "barrel" is formed by periclinal divisions of the circle of cells forming the margin of the young pore. The first division results in an inner and an outer tier of cells (FIG. 20). The inner tier by a series of divisions forms the portion projecting into the chamber; the outer tier by a series of similar but later divisions gives rise to the outer portion of the pore (FIG. 21). The inner projection of the pore consists of five or six tiers of cells, the outer of three or four, the circle next the pore becoming cutinized at maturity (FIG. 22).

THE MALE RECEPTACLE

The tissue of the male receptacle is compact, aside from the antheridial chambers and very few air chambers appear on the disc. These are situated along the margins and are relatively simple in structure, containing only simple pores. In this respect the writer's observations agree with those of Haupt (**9**) but differ from those of Cavers (**4**, **5**), who described and figured small barrel-shaped pores in the male receptacle of *Reboulia hemisphaerica*.

SUMMARY

The very elongated air chambers of the thallus extend lengthwise along the midrib region and from this radiate pinnately toward the margins of the thallus.

The air chamber tissue consists essentially of a single series of oblique chambers extending from the surface to the compact tissue, overlapping one another shingle-like and thus giving the appearance in section of several series of superimposed chambers.

The primary chambers are extensively subdivided into partial secondary chambers by plates of cells arising as lateral outgrowths of the primary walls.

The air chambers of both thallus and receptacles originate by splitting of cell membranes, the splits arising both internally and superficially, and generally proceeding from both points of origin simultaneously.

The later development of the chambers and the secondary partitioning is due largely to growth of the tissues, further splitting apparently playing but a small rôle in the process.

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LITERATURE CITED

1. **Barnes, C. R., & Land, W. J. G.** Bryological papers. I. The origin of air chambers. Bot. Gaz. **44**: 197–213. *f. 1–22.* 1907.
2. **Black, C. A.** The morphology of *Riccia Frostii*, Aust. Ann. Bot. **27**: 511–532. *pl. 37, 38.* 1913.
3. **Campbell, D. H.** Mosses and Ferns. 3d ed. New York. 1918.
4. **Cavers, F.** Contributions to the biology of the Hepaticae. Part I. *Targionia, Reboulia, Preissia, Monoclea.* Leeds and London. 1904.

5. —— Notes on Yorkshire Bryophytes. III. *Reboulia hemisphaerica* (L.) Raddi. Naturalist 1904: [1–15]. *pl. 8 + f. 2–6.* 1904.

6. **Deutsch, H.** A study of *Targionia hypophylla*. Bot. Gaz. **53**: 492–503. *f. 1–13.* 1912.

7. **Evans, A. W.** The air chambers of *Grimaldia fragrans*. Bull. Torrey Club **45**: 235–251. *f. 1–14.* 1918.

8. **Goebel, K.** Organographie der Pflanzen. II. Spezielle Organographie. 2d ed. **1**. Bryophyten. Jena. 1915.

9. **Haupt, A. W.** The gametophyte and sex organs of *Reboulia hemisphaerica*. Bot. Gaz. **71**: 61–74. *f. 1–21.* 1921.

10. **Hirsh, P.** The development of the air chambers in the Ricciaceae. Bull. Torrey Club. **37**: 73–77. *f. 1–6.* 1910.

11. **Hofmeister, W.** Higher Cryptogamia. Eng. ed. London. 1862.

12. **Leitgeb, H.** Untersuchungen über die Lebermoose. 4. Die Ricceen. Graz. 1879.

13. —— Die Athemöffnungen der Marchantiaceen. Sitzb. Kais. Akad. Wiss. Wien **81**: 40–54. *pl. 1.* 1880.

14. —— Untersuchungen über die Lebermoose. 6. Die Marchantieen und allgemeine Bemerkungen über Lebermoose. Graz. 1881.

15. **O'Keefe, L.** Structure and development of *Targionia hypophylla*. New Phytol. **14**: 105–116. *f. 1, 2.* 1915.

16. **Starr, A. M.** A Mexican *Aytonia*. Bot. Gaz. **61**: 48–58. *pl. 1–4 + f. 30–33.* 1916.

Anomalies in maize and its relatives—I

PAUL WEATHERWAX

(WITH FIVE TEXT FIGURES)

A series of investigations on the grasses included in the tribe Maydeae (Tripsaceae in the recent literature) have incidentally brought under observation a number of characteristics sufficiently infrequent in occurrence to be termed anomalies. Some of these are unmistakably peculiarities of development determined by disease, mechanical injury, or other environmental influence; for others no definite cause can readily be assigned. Some are non-inherited fluctuations in which highly specialized structures revert in development to a more primitive condition; but others cannot be explained in terms of past history.

While none of these teratological occurrences have any economic significance, and few of them make any definite contribution to matters of purely botanical interest, yet they should be recorded in the literature of science for whatever they may be worth in our efforts to understand the maize plant and its relatives. Accordingly, the present is the first of a series of such contributions, which the writer purposes to make from time to time.

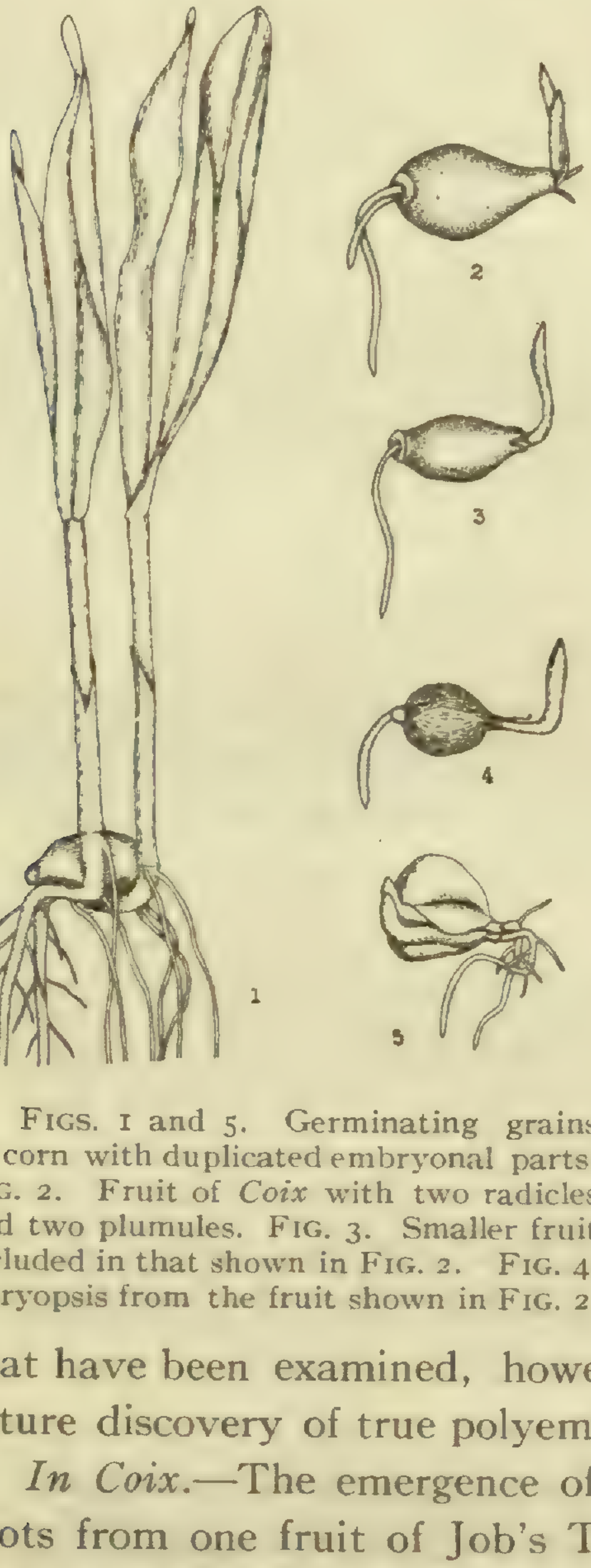
FALSE POLYEMBRYONY

In Maize.—On two occasions there have been found seeds of maize, each of which apparently contained two embryos. The first was a grain of Black Mexican sweet corn, which, due to wet weather at the time of maturity, had germinated while still inside the husk. Two plumules and two primary roots had emerged from the pericarp (FIG. 5). The second was in a lot of seedlings being grown for study. One grain was found bearing two stalks and two well-developed root systems (FIG. 1).

But dissection showed in each case that, although the coleoptile and coleorhiza were also duplicated, there was only one cotyledon.

The anomalous embryo had doubtless arisen from a single fecundated egg, and had been influenced in development by some unexplained disturbance of polarity at the time of the differentiation of the embryonal axis in the thalloid primordium. But in

none of the hundreds of embryos that have been sectioned in a study of this phase of development has there been observed anything to account for this division of the growing points.



FIGS. 1 and 5. Germinating grains of corn with duplicated embryonal parts. FIG. 2. Fruit of *Coix* with two radicles and two plumules. FIG. 3. Smaller fruit included in that shown in FIG. 2. FIG. 4. Caryopsis from the fruit shown in FIG. 2.

Three or four other instances of apparently the same anomaly have been brought to the writer's attention at different times, but opportunity for satisfactory examination has in each case been lacking. In one of these, the grain bore three stalks. Otherwise there is no ground for belief that any of these were essentially different from those described.

If we except the "fasciated" grains that have been reported,* which, being the results of fusion of grains, are really out of the realm of our present consideration, there seems to be no case on record of the occurrence of two separate embryos in any one seed of maize. The limited number of these anomalies that have been examined, however, leaves ample room for the future discovery of true polyembryony in maize.

In Coix.—The emergence of two plumules and two primary roots from one fruit of Job's Tears (*Coix lachryma-Jobi* L.) led to an examination to determine whether or not the enclosed seed had two embryos.

Removal of the hard outer shell (FIG. 2) disclosed, in addition to the expected caryopsis (FIG. 4) with its quota of bracts,

* Wolfe, T. K. Fasciation in maize kernels. Amer. Nat. **50**: 306–309. *f.* 1–3. 1916.

another entire fruit (FIG. 3). The shell of the latter was thinner and softer than in the ordinary fruit.

The structure of the anomaly is readily explained, but the data at hand afford no explanation of the cause. The inflorescence of *Coix* consists of a single axis bearing on its terminal portion ten to fifty or more staminate spikelets, and at its base one to three pistillate spikelets. Each of the latter is surrounded by a modified leaf sheath which matures into the stony shell of the fruit. Through failure of the axis to elongate sufficiently in development, the upper spikelet and its sheath had been included in the spathe of the lower.

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INDEX TO AMERICAN BOTANICAL LITERATURE

1911–1921

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Reviews, and papers that relate exclusively to forestry, agriculture, horticulture, manufactured products of vegetable origin, or laboratory methods are not included, and no attempt is made to index the literature of bacteriology. An occasional exception is made in favor of some paper appearing in an American periodical which is devoted wholly to botany. Reprints are not mentioned unless they differ from the original in some important particular. If users of the Index will call the attention of the editor to errors or omissions, their kindness will be appreciated.

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Craib, W. G. Leguminosae. In Sargent, C. S., Plantae Wilsonianae **2**: 87–119. 24 Mr 1914.

Dunn, S. T. *Millettia.* In Sargent, C. S., Plantae Wilsonianae **2**: 101, 102. 24 Mr 1921.

Focke, W. O., *Rubus.* In Sargent, C. S., Plantae Wilsonianae **1**: 48–56. 31 Jl 1911.

Gagnepain, F. Vitaceae. In Sargent, C. S., Plantae Wilsonianae **1**: 99–105. 31 Jl 1911.

Gamble, J. S. Lauraceae. In Sargent, C. S., Plantae Wilsonianae **2**: 66–86. 24 Mr 1914.

Harms, H., & Rehder, A. Araliaceae. In Sargent, C. S., Plantae Wilsonianae **2**: 555–568. 30 Mr 1916.

Hutchinson, J. Euphorbiaceae. In Sargent, C. S., Plantae Wilsonianae **2**: 516–529. 30 Mr 1916.

Hutchinson, J. Rubiaceae. In Sargent, C. S., Plantae Wilsonianae **3**: 390–417. 31 Au 1916.

Janczewski, E. *Ribes.* In Sargent, C. S., Plantae Wilsonianae **1**: 44–46. 31 Jl 1911.

Koehne, E. *Prunus.* In Sargent, C. S., Plantae Wilsonianae **1**: 59–75. 31 Jl 1911; **1**: 196–282. 30 Ap 1912.

Koehne, E. *Maddenia.* In Sargent, C. S., Plantae Wilsonianae **1**: 56–59. 31 Jl 1911.

Koehne, E. *Philadelphus.* In Sargent, C. S., Plantae Wilsonianae **1**: 4–6. 31 Jl 1911; **1**: 145. 30 Ap 1912.

Koehne, E. *Sorbus.* In Sargent, C. S., Plantae Wilsonianae **1**: 457–484. 15 My 1913.

Lecomte, H. Loranthaceae. In Sargent, C. S., Plantae Wilsonianae **3**: 315–319. 31 Au 1916.

Levin, I., & Levine, M. Malignancy of the crown-gall and its analogy to animal cancer. Jour. Cancer Research **5**: 243–260. *f. 1–15.* 1920.

Lingelsheim, A. *Fraxinus.* In Sargent, C. S., Plantae Wilsonianae **2**: 258–262. 24 Mr 1914.

Lintl, H. *Echinopsis multiplex.* Monatsschr. Kakteenk. **27**: 123, 124. Au 1917.

Loesener, T. Aquifoliaceae. In Sargent, C. S., Plantae Wilsonianae **1**: 76–82. 31 Jl 1911.

Loesener, T., & Rehder, A. Celastraceae. In Sargent, C. S., Plantae Wilsonianae **1**: 485–487. 15 My 1913.

Loftfield, G. V. Behavior of stomata. Carnegie Inst. Washington Year Book **19**: 343, 344. 3 F 1921.

Lutz, F. E. Geographic average, a suggested method for the study of distribution. Am. Mus. Novit. **5**: 1–7. 14 Mr 1921.

MacDougal, D. T. Biological and physical factors affecting plants in new habitats. Carnegie Inst. Washington Year Book **19**: 69–71. 3 F 1921.

MacDougal, D. T. Course of growth in trees as measured by the dendrograph. Carnegie Inst. Washington Year Book **19**: 49, 50. 3 F 1921.

MacDougal, D. T. Growth and the accumulation of reserve material as measured in the potato. Carnegie Inst. Washington Year Book **19**: 51. 3 F 1921.

MacDougal, D. T. Measurement of a season's growth of trees by the newly designed dendrometer. Carnegie Inst. Washington Year Book **19**: 50. 3 F 1921.

MacDougal, D. T., & Spoehr, H. A. Components and colloidal behavior of plant protoplasm. Carnegie Inst. Washington Year Book **19**: 53–57. 3 F 1921.

Mann, A. Continuation of investigations and preparations for publication of results of work on Diatomaceae. Carnegie Inst. Washington Year Book **19**: 326–329. 3 F 1921.

Marshall, L. Contributions of the plant breeder to the vegetable garden. Am. Bot. **27**: 8–17. F 1921.

Merrill, E. D. Comments on Cook's theory as to the American origin and prehistoric Polynesian distribution of certain economic plants, especially *Hibiscus tiliaceus* Linnaeus. Philipp. Jour. Sci. **17**: 377–384. O 1920.

Merrill, E. D. *Myrmeconauclea*, a new genus of rubiaceous plants from Palawan and Borneo. Philipp. Jour. Sci. **17**: 375, 376. O 1920.

Meyer, R. Verschiedenes über die Arten der Untergattung *Ancistrocarpus*. Monatsschr. Kakteenk. **27**: 72–80, 99–103. 1917.

Murrill, W. A. The papaya, or tree melon. Sci. Am. **124**: 191. 5 Mr 1921.

Murrill, W. A. The genus *Tinctoporia*. Mycologia **13**: 122, 123. 26 Mr 1921.

Includes 3 new combinations.

Meyer, R. Über einen originellen *Echinocactus capricornus* Dietr. Monatsschr. Kakteenk. **26**: 97, 98. Jl 1916.

Meyer, R. *Echinocactus centeterius* Lem. Monatsschr. Kakteenk. **27**: 60, 61. Ap 1917. [Illust.]

Meyer, R. *Echinocactus hexaëdrophorus* Lem. var. *Droegeanus* Hildm. Monatsschr. Kakteenk. **27**: 40–44. Mr 1917. [Illust.]

Meyer, R. *Echinocactus Jussieui* Monv. Monatsschr. Kakteenk. **27**: 52, 53. Ap 1917. [Illust.]

Meyer, R. Über *Echinocactus multiflorus* Hook. Monatsschr. Kakteenk. **26**: 66, 67. My 1916. [Illust.]

Meyer, R. Über *Echinocactus senilis* R. A. Phil. Monatsschr. Kakteenk. **26**: 157, 158. O 1916.

Meyer, R. Einiges über *Echinocactus tabularis* Cels. Monatsschr. Kakteenk. **26**: 56. Ap 1916. [Illust.]

Meyer, R. *Echinocereus pulchellus* K. Sch. Monatsschr. Kakteenk. **26**: 177, 178. D 1916. [Illust.]

Meyer, R. Über das System der Gattung *Echinopsis* Zucc. Monatsschr. Kakteenk. **26**: 72–76. My 1916.

Meyer, R. Die Unterscheidungsmerkmale der Arten in der Untergattung *Malacocarpus* K. Sch. Monatsschr. Kakteenk. **27**: 49–52. Ap 1917.

Meyer, R. Über *Melocactus communis* Lk. et Otto. Monatsschr. Kakteenk. **26**: 114–120. Au 1916. [Illust.]

Mez, C. Additamenta monographica 1919. II. Lauraceae. III. Myrsinaceae. Repert. Sp. Nov. Regn. Veg. **16**: 305–312. 30 Ap 1920.

New American species in *Ajouea*, *Acrodiclidium*, *Silvia*, *Endlicheria*, *Ocotea*, *Nectandra*, and *Ardisia*.

Miles, L. E. Leaf spots of the elm. Bot. Gaz. **71**: 161–196. *pl. 8–10*. 17 Mr 1921.

Includes 2 new species of *Gloeosporium*.

Moulton, R. H. A remarkable twin tree. Gard. Mag. **33**: 50. Mr 1921. [Illust.]

Close association of oak and elm.

Murrill, W. A. A double mushroom. Mycologia **13**: 119–122. *f. 1–3*. 26 Mr 1921.

Agaricus campester.

Murrill, W. A. Two species of *Fuscoporia*. Mycologia **13**: 119. 26 Mr 1921.

2 new combinations.

Noack, K. L. Untersuchungen über die Individualität der Plastiden bei Phanerogamen. Zeitschr. Bot. **13**: 1–35. *pl. 1, 2* + *f. 1–3*. 1921.

Among species studied is *Elodea canadensis*.

Nordhagen, R. Om nomenklatur og begrepsdannelse i plantesociologien. Nyt Mag. Naturvid. **57**: 17–128. 11 F 1920.

Norton, J. B. Liliaceae. In Sargent, C. S., Plantae Wilsonianae **3**: 1–13. 8 My 1916.

Rehder, A. Aceraceae. In Sargent, C. S., Plantae Wilsonianae **1**: 83–98. 31 Jl 1911.

Rehder, A. Alangiaceae. In Sargent, C. S., Plantae Wilsonianae **2**: 552–554. 30 Mr 1916.

Rehder, A. Bignoniaceae. In Sargent, C. S., Plantae Wilsonianae **1**: 303–305. 30 Ap 1912.

Rehder, A. Caprifoliaceae. In Sargent, C. S., Plantae Wilsonianae **1**: 106–144. 31 Jl 1911; **1**: 306–312. 30 Ap 1912; **2**: 617–619. 30 Mr 1916.

Rehder, A. *Cardiandra*. In Sargent, C. S., Plantae Wilsonianae **1**: 24. 31 Jl 1911.

Rehder, A. Chloranthaceae. In Sargent, C. S., Plantae Wilsonianae **3**: 15. 8 My 1916.

Rehder, A. Cornaceae. In Sargent, C. S., Plantae Wilsonianae **2**: 569–579. 30 Mr 1916.

Rehder, A. *Decumaria*. In Sargent, C. S., Plantae Wilsonianae **1**: 152. 30 Ap 1912.

Rehder, A. *Deutzia*. In Sargent, C. S., Plantae Wilsonianae **1**: 6–24. 31 Jl 1911; **1**: 146–150. 30 Ap 1912.

Rehder, A. *Dichroa*. In Sargent, C. S., Plantae Wilsonianae **1**: 43, 44. 31 Jl 1921.

Rehder, A. Dilleniaceae. In Sargent, C. S., Plantae Wilsonianae **2**: 378–389. 28 D 1915.

Rehder, A. Dioscoreaceae. In Sargent, C. S., Plantae Wilsonianae **3**: 14. 8 My 1916.

Rehder, A. Elaeagnaceae. In Sargent, C. S., Plantae Wilsonianae **2**: 409–417. 28 D 1915.

Rehder, A. *Exochorda*. In Sargent, C. S., Plantae Wilsonianae **1**: 456, 457. 15 My 1913.

Rehder, A. *Forsythia*. In Sargent, C. S., Plantae Wilsonianae **1**: 302. 30 Ap 1912.

Rehder, A. Gesneraceae. In Sargent, C. S., Plantae Wilsonianae **3**: 387–389. 31 Au 1916.

Rehder, A. *Hypericum*. In Sargent, C. S., Plantae Wilsonianae **2**: 402–405. 28 D 1915.

Rehder, A. Hippocastanaceae. In Sargent, C. S., Plantae Wilsonianae **1**: 488–500. 15 My 1913.

Rehder, A. *Hydrangea*. In Sargent, C. S., Plantae Wilsonianae **1**: 25–41. 31 Jl 1911; **1**: 150, 151. 30 Ap 1912.

Rehder, A. *Itea*. In Sargent, C. S., Plantae Wilsonianae **1**: 44. 31 Jl 1911.

Rehder, A. Labiatae. In Sargent, C. S., Plantae Wilsonianae **3**: 380–384. 31 Au 1916.

Weaver, J. E. Plant production quadrats. Carnegie Inst. Washington Year Book **19**: 357, 358. 3 F 1921.

Weaver, J. E. Root development and absorption. Carnegie Inst. Washington Year Book **19**: 358. 3 F 1921.

Weidlich, E. *Echinopsis Pentlandii* var. *albiflora* Weidlich var. nov. Gartenflora **69**: 143, 144. *f. 17*. 15 N 1920.

Weingart, W. *Cereus Napoleonis* Grah. und *Cereus Napoleonis* Hort. Grus. Monatsschr. Kakteenk. **26**: 76–79. My 1916.

Weingart, W. Extranuptiale Nectarien. Monatsschr. Kakteenk. **26**: 101–105. Jl 1916.

Wernham, H. F. Tropical American Rubiaceae—XIII. Jour Bot. **58**: 105–108. Mr 1920.
Includes *Coupoui brasiliensis* sp. nov., from Brazil.

Wherry, E. T. The soil reactions of the ferns of woods and swamps. Am. Fern Jour. **11**: 5–16. Mr 1921.

Whitaker, E. S. Experimental investigations on birch and oak. Bot. Gaz. **71**: 220–235. *pl. 12–15* + *f. 1–4.* 17 Mr 1921.

Wiggans, R. G. Variations in the osmotic concentration of the guard cells during the opening and closing of stomata. Am. Jour. Bot. **8**: 30–40. *f. 1–7.* 9 Mr 1921.
Studied experimentally *Zebrina, Cyclamen, Iresine* and *Beta.*

Williams, R. S. Mosses of the Canadian Arctic Expedition, 1913–18, Rep. Canad. Arct. Exped. 1913–18. **4**[e]: 1–15. *f. 1–18.* 8 F 1921.
Includes *Barbula Johansenii* and *Chrysohypnum arcticum*, spp. nov.

Wilson, E. H. *Amelanchier.* In Sargent, C. S., Plantae Wilsonianae **1**: 195, 196. 30 Ap 1912.

Wilson, E. H. Boraginaceae. In Sargent, C. S., Plantae Wilsonianae **3**: 363–365. 31 Au 1916.

Wilson, E. H. Eucommiaceae. In Sargent, C. S., Plantae Wilsonianae **1**: 433. 15 My 1913.

Wilson, E. H. Flacourtiaceae. In Sargent, C. S., Plantae Wilsonianae **1**: 283–286. 30 Ap 1912.

Wilson, E. H. Myricaceae. In Sargent, C. S., Plantae Wilsonianae **3**: 189. 31 Au 1916.

Wilson, E. H. Nyssaceae. In Sargent, C. S., Plantae Wilsonianae **2**: 254–257. 24 Mr 1914.

Wilson, E. H. *Osteomeles.* In Sargent, C. S., Plantae Wilsonianae **1**: 184. 30 Ap 1912.

Wilson, E. H. Plumbaginaceae. In Sargent, C. S., Plantae Wilsonianae **2**: 586. 30 Mr 1916.

Wilson, E. H. *Pyracantha.* In Sargent, C. S., Plantae Wilsonianae **1**: 177, 178. 30 Ap 1912.

Winston, J. R. Tear-stain of *Citrus* fruits. U. S. Dept. Agr. Farmers' Bull. 924: 1–12. *pl. 1, 2.* 26 Ja 1921.

Woodruff, L. L. History of biology. Sci. Mo. **12**: 253–281. Mr 1921.

Youngken, H. W. Studies on the Cassaba and Honey Dew melons. Am. Jour. Pharm. **93**: 104–115. *f. 1–12.* F 1921.

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BULLETIN

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Distribution of Berberis vulgaris in Pennsylvania*

FRANK D. KERN

During the war extensive campaigns of barberry eradication were inaugurated in the North Middle States because of the part it was believed the barberry played there in the spread of black stem rust of cereals. Later more or less systematic attempts were made to gather facts regarding the barberry and the spread of rust in other parts of the United States. In this work the Office of Cereal Investigations, U. S. Department of Agriculture, cooperated with pathologists and botanists in various states. In Pennsylvania, where the writer assisted in an investigation of the situation, aid was furnished by the Office of Cereal Investigations during the summer of 1919 in the form of expenses for travel, and in the assignment of Mr. Creighton F. Murphy, a special appointee of that office, for work in this state. To the organizing ability and untiring activity of Mr. Murphy is due a large part of any success attained.

One of the first things necessary was to obtain information regarding the prevalence of the barberry in the region. The barberry, *Berberis vulgaris*, is not a native of America but was introduced, doubtless from Europe, cultured either as an ornamental shrub for its fruit, which has been more or less prized for culinary purposes, or as a medicinal plant. It has escaped from cultivation and in some localities in the United States is

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known to be thoroughly established. In any investigation of the distribution of this plant cognizance must be taken of the fact that it is still largely cultivated and that it exists also as an escape. I wish to deal chiefly with the latter phase in the present paper. No attempt is made here to present any conclusions regarding the connection of the barberry to the rust situation.

By turning to the manuals or floras of the northeastern states it was not possible to form a very definite conception of the probable distribution of *Berberis vulgaris* as a wild plant of Pennsylvania. Gray's Manual states that it is to be found in "thickets and waste grounds in eastern and southern New England, where it has become thoroughly wild; elsewhere occasionally spontaneous." This did not indicate that it would likely be found at all common or thoroughly wild in Pennsylvania although our results have shown this to be the case. Britton & Brown's "Illustrated Flora" gives the distribution as "thickets, naturalized from Europe in the Eastern and Middle States, adventive in Canada and the west."

Among the more local publications one would turn first to Porter's Flora of Pennsylvania. Here distribution, as it was known to the author, is outlined by counties. Northampton, Franklin, and Susquehanna are listed under *Berberis vulgaris*. This was a definite beginning. Here were three counties in which this plant was known as an escape to Porter, some time during his botanical career, 1836–1901. Other local publications in the form of regional and county floras soon added additional localities, Dudley & Thurston's Flora of the Lackawanna and Wyoming Valleys (1892) records one bush, west of Archbald, Lackawanna County, and one in a swamp near Kingston, Luzerne County. Twining's Flora of Northeastern Pennsylvania (1917) reports *B. vulgaris* as "local; a pest near Waverly and Wallsville" both in Lackawanna County. Fretz, in a Flora of Bucks County (1905). gives three stations, Bensalem, near Jericho Hill, and Doylestown. From the foregoing account it will be seen that, without an undue search of the literature, definite information was obtained that the barberry had been known as an escape in six Pennsylvania counties. Most of these reports were founded on observations made several years before and in order to know the present day

situation it was evident that further investigations were necessary. As an example of the way in which the literature may fail to be of assistance the case of Lancaster County may be cited. Small & Carter's Flora of Lancaster County (1913) makes no mention of the barberry although our work shows that the plant has been established there in several places for a considerable time, most certainly prior to 1913.

Next to the literature, and more important in some ways in a matter of this sort, are herbaria. Specimens in a herbarium are usually accompanied with definite information as to place and date of collection, two extremely important points in tracing distribution. The two leading herbaria in the state, the one at the Academy of Natural Sciences, Philadelphia, and the other at Carnegie Museum, Pittsburgh, were consulted and both yielded valuable information. More than a dozen other institutional or private collections were examined. Contrary to our expectations the Porter specimens were seen at the Academy of Sciences, Philadelphia, and not at Lafayette College, Easton. A number of years ago, in 1896 or thereabout, fire damaged the herbarium of Dr. T. C. Porter, upon which the Flora of Pennsylvania was founded, and most of the herbarium was transferred to the Philadelphia Academy.

The most direct aid in checking up localities where barberries previously existed, or in going to new localities, came from the enthusiastic cooperation of persons in all parts of the state, who were interested in plants and had special knowledge concerning particular regions. The finding of so large a number of persons interested in plants and botanical matters was most gratifying, and the contact with them was a most delightful experience as well as being our most valuable asset in this piece of work. Altogether a list of more than 200 names was brought together and more than half of these, approximately 116, were consulted either by personal interview or through correspondence. Starting with the names of those appearing on herbarium specimens and enlarging this to include botany and science teachers in various institutions a sizeable nucleus of botanical enthusiasts was obtained. A person interested in the wild and native plants frequently knew someone in his own or a neighboring county who was also

interested. County agricultural agents often knew the persons in their counties who made botanical collections or observations. Curators of museums, custodians of historical societies, foresters and fire wardens were usually interested themselves or had knowledge of the persons who were. Thus our list grew.

The following lists present in detail the localities where *Berberis vulgaris* has been found growing wild. Altogether the literature and herbarium specimens mention nineteen localities in fourteen different counties. In our work we were able to verify the existence of barberry in 1919 in only two of these stations. Not all of the nineteen were investigated. In spite of specific directions and suggestions we found it impossible to relocate some of the stations. In other cases it is entirely probable that a single bush or two may have formed the basis of the original report and that they had disappeared prior to our investigation. Fourteen new localities are here reported, involving ten counties.

LOCALITIES MENTIONED IN THE LITERATURE

BUCKS COUNTY: Bensalem, *I. C. Martindale;* near Jericho Hill, *Dr. E. Newlin Williams;* Doylestown, *Professor A. S. Martin* (Fretz, Flora of Bucks County [Appendix to a county history ?], 1905).

FRANKLIN COUNTY: locality not given (Porter, Flora of Pennsylvania, 1903).

LACKAWANNA COUNTY: west of Archbald (Dudley & Thurston, Flora of Lackawanna and Wyoming Valleys, 1892); near Waverly and Wallsville (Twining, Flora of Northeastern Pennsylvania, 1917).

LUZERNE COUNTY: swamp, near Kingston (Dudley & Thurston, *l.c.*).

NORTHAMPTON COUNTY: locality not given (Porter, *l.c.*).

PHILADELPHIA COUNTY: Germantown, *E. C. Jellett* (Handbook of the Flora of Philadelphia and vicinity).

SUSQUEHANNA COUNTY: locality not given (Porter, *l.c.*)

LOCALITIES MENTIONED ON HERBARIUM SPECIMENS*

BERKS COUNTY: half mile south of Fleetwood, August 27, 1915, *W. H. Leibelsperger* (Acad.).

* The following abbreviations are used in this list: Acad., for Philadelphia Academy of Sciences; C. M., for Carnegie Museum, Pittsburgh; U. of P., for University of Pennsylvania, Philadelphia.

BUCKS COUNTY: near Doylestown, May–August, 1880, ex. herb. *C. D. Fretz* (Acad.).

CAMERON COUNTY: Driftwood, across the Sinnemahoning, September, 1898, *John A. Shaffer* (C.M. *498*).

CHESTER COUNTY: in a thicket one mile southwest of Kennett Square, June 8, 1875, *A. Common* (Acad.).

DELAWARE COUNTY: near Cooperstown, on road from Darby Creek, November 15, 1903; September 18, 1904, *B. W. Griffiths* (Acad.); Darby Creek, May 15, 1919, *Dr. M. W. Henderson* (U. of P.).

ERIE COUNTY: Happy Valley, roadsides, May 1893, *John Miller* (Historical Society); near woolen mill, October 1, 1893, *John Miller* (Historical Society).

FRANKLIN COUNTY: Mercersburg, 1846, Porter Herbarium (Acad.).

LANCASTER COUNTY: Rawlinsville, May–June, 1885, ex. herb. *James Galen 91* (C. M. *1697*).

LUZERNE COUNTY: Myers Swamp, Kingston, 1891, *C. O. Thurston* (Wyoming Seminary).

MONTGOMERY COUNTY: Shannonville (now Audubon) along Perkiomen, July 15, 1892, Herb. *Jas. Crawford* (Acad.); banks of Perkiomen, locustwoods, May 5, 1891, *J. Crawford* (Herb. J. B. Brinton *1443*, U. of P.).

NORTHAMPTON COUNTY: vicinity of Easton, May, 1867, *A. P. Garber 1396* (F. & M.); escaped into copses and woods, Easton; May 25, 1887, *Thos. C. Porter* (Acad.); Easton, May 29, 1896, July 15, 1897; May 25, 1899, *Thos. C. Porter* (Acad.); roadside, College Hill, Easton, September 8, 1898, *Thos. C. Porter* (C. M.); Easton, May 17, 1889, *Thos. C. Porter* (C. M. *2116*).

SUSQUEHANNA COUNTY: vicinity of Ararat, elevation 2000–2700 ft., July 8–20, 1900, *C. F. Saunders* (Acad.).

VERIFICATION OF CITATIONS OR COLLECTIONS

BERKS COUNTY: vicinity of Fleetwood, numerous mature bushes. *Specimens:* half mile south of Fleetwood, Ruscomb Manor Township, July 25, 1919, *Leibelsperger, Kern, & Murphy.*

LACKAWANNA COUNTY: near Waverly, exceedingly numerous large bushes.

NEW LOCALITIES

CENTER COUNTY: near Pennsylvania Furnace, twelve miles southwest of State College, numerous large bushes; woodlot on College farm, Pennsylvania State College, observed by C. R. Orton, 1920.

CUMBERLAND COUNTY: near Shippensburg, which is on the line between Cumberland and Franklin Counties.

ERIE COUNTY: in a ravine in city of Erie, a few bushes. *Specimens:* near Rolling Mill site in a ravine, Erie, August 29, 1919, *Miss Cora Smith & F. D. Kern.*

FRANKLIN COUNTY: vicinity of Shippensburg, exceedingly numerous large bushes. *Specimens:* Shippensburg, June 30, 1919, *F. D. Kern.*

LACKAWANNA COUNTY: Frequent in the vicinity of Dalton and Glenburn. *Specimens:* John Woodbridge farm, Dalton, July 31, 1919, *Kern & Murphy;* woodlot of Mrs. Edw. Northrup, Glenburn, July 4, 1919, *C. F. Murphy.*

LANCASTER COUNTY: several localities, thoroughly established. *Specimens:* in thickets along stream, near an old hedge, near Ronk, Strasburg Township, June 29, 1919, *F. D. Kern;* Jacob King Farm, Strasburg Township, June 7, *C. F. Murphy;* near Mt. Nebo Presbyterian Church, Martic Township, July 24, 1919, *Kern & Murphy.*

LEBANON COUNTY: near South Lebanon, origin in seed planted thirty-five years ago, now being dug out.

LEHIGH COUNTY: vicinity of Schoenersville, only two plants seen. *Specimens:* roadside, mile and a half west by southwest of Schoenersville, September 26, 1920, *H. W. Pretz 10535.*

SUSQUEHANNA COUNTY: Brooklyn Township, exceedingly numerous on hillsides and in open woods. *Specimens:* along Scranton-Montrose trolley, between Dimock road and Smith crossing, Brooklyn Township, August 1, 1919, *Kern & Murphy;* Geo. Burgiss farm, Brooklyn Township, July 7, 1919, *C. F. Murphy.*

WYOMING COUNTY: vicinity of Russell Hill, thousands of bushes, forming thickets in pastures.

Judging from its present distribution in Pennsylvania the barberry bush is able to establish itself under varied natural

conditions. Residual soils, whether formed from sandstone and shale, limestone, or igneous and metamorphic rocks, seem to be favorable. Glacial soil seems to be equally favorable although its drainage is poor compared with the residual soils. In thickets along streams, along roadsides, in open pastures, or half-wooded hillsides this plant seems to be at home. The seeds germinate readily and the seedlings are vigorous. Birds and browsing cattle are agents of seed dispersal. Observations on the dissemination of the barberry have been embodied in a separate paper (Ecology, July, 1921). The fact must be kept in mind that in North America *Berberis vulgaris* was first a cultivated plant which has escaped. It is without doubt now more widely distributed than it is generally supposed to be. It is a fateful plant on account of its connection with the black stem rust of cereals and grasses and information concerning its presence as a part of our wild flora is of value.

DEPARTMENT OF BOTANY,
THE PENNSYLVANIA STATE COLLEGE

The development of prothallia and antheridia from the sex organs of Polypodium irioides

W. N. Steil

(WITH PLATE 4 AND FOUR TEXT FIGURES)

Introduction

The spores of *Polypodium irioides* Poir., from the culture of which were obtained the prothallia with the sex-organs to be described, were sown March 21, 1916. When the first prothallia had grown to maturity and a number had already produced sporophytes, the majority were removed for class use. Antheridia and archegonia were formed on the prothallia in large numbers. The archegonia, as is usual in most ferns, were produced on the cushion back of the apical notch, and the antheridia in the majority of cases on the posterior portion among the rhizoids. They were also frequently formed along the margins of the prothallia. In a few instances antheridia were observed among the archegonia.

On several occasions prothallia were examined with the microscope, but no abnormalities were observed in the development of the sex-organs. The smaller prothallia, as well as the larger ones, produced secondary prothallia in profusion. A modified Beyerinck's solution* was several times applied to the *Sphagnum* on which the prothallia were grown. The illumination and the carbon dioxide and oxygen supply were sufficient for normal development of prothallia. The vigorous growth and the large size of the prothallia suggest that favorable conditions prevailed in the culture at least during its early history.

The majority of the remaining prothallia were removed in October, 1918. Three sporophytes remained in the culture at this time and from these sporophytes sporophytic and aposporous

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*See Moore, G. T. Methods for growing pure cultures of Algae. Jour. Appl. Microscopy **6**: 2309–2314. 1903.

growths were later produced. For a description of these the reader is referred to another paper.*

The figures made as a result of this investigation were drawn with the aid of a camera lucida from living material. Some of the prothallia with the abnormal archegonia were fixed in Flemming's medium fluid, imbedded in paraffin, sectioned and finally stained with safranin and light green.

ANTHERIDIA

In the autumn of 1918, when the first sporophytes were observed to produce secondary sporophytes, the antheridia and archegonia to be described were discovered.

The majority of the antheridia appeared normal at this time, producing actively motile antherozoids. When these sex-organs were mature, the sterile cells contained only a few chloroplasts. A large number of abnormal antheridia developed among the normal ones. The lid cell and the two ring cells of the abnormal type of antheridium contained usually a large number of chloroplasts. Such antheridia were primarily vegetative in character and only occasionally produced mature antherozoids. These antheridia were not confined to the older prothallia, but were most frequently found on the younger filaments or secondary prothallia, which (as has already been stated) were commonly developed in the culture after some of the larger prothallia were removed.

FIG. 1. A portion of a prothallium of *Polypodium irioides* from which a filament was produced. An antheridium at the end of the filament developed a prothallium. × 20.

From the sterile cells of these antheridia prothallial filaments or secondary antheridia were frequently produced. The most common cases of regeneration were observed in connection with the lid cell. Such filaments always consisted of a single row of cells. Early stages in the development of the filaments are represented in FIGS. 1 and 2 of PLATE 4. These filaments were observed to

* Steil, W. N. Vegetative reproduction and aposporous growths from the young sporophyte of *Polypodium irioides*. Bull. Torrey Club **48**: 203–205. *f.* 1–3. 1921.

broaden out in some instances and form heart-shaped prothallia with rhizoids and antheridia. (TEXT FIG. 1.) The antherozoids produced in the antheridia were seldom discharged in these instances and undoubtedly disintegrated. One of the ring cells of the antheridium represented by FIG. 2 developed a secondary antheridium from which the antherozoids had already escaped.

In many instances, the sterile cells of an antheridium produced secondary antheridia. Sometimes several of these were developed from the lid cell. FIG. 3 represents a lid cell (*a*) from which an antheridium (*b*) was produced. From the lid cell (*d*) of the larger secondary antheridium (*c*) a normal one (*e*) was developed. Occasionally a ring cell produced one or more antheridia (FIGS. 4–6).

The spermatogenous cells in antheridia whose sterile cells contained many chloroplasts, in several instances were observed to have disintegrated. Such antheridia were sometimes transformed into prothallia (FIGS. 7–9). The cells of such antheridia usually increased in size and often divided into a number of cells (FIG. 10). The great difference between normal and such abnormal antheridia is shown by FIG. 9. Many-celled prothallia produced from this kind of antheridium were found in the culture.

Antheridia were also transformed into prothallia during their early course of development. It was obviously difficult to follow the development of these prothallia. An early stage in the transformation of an antheridium is shown by FIG. 11. The ring cells, in this instance, had divided to produce several cells. In some cases plastids were present in the central portion of the antheridium. These were, however, almost colorless, containing little chlorophyl. In this respect the young prothallia of this type differed from the ordinary secondary prothallia. The development of these prothallia could be followed only during their early stages, since at later stages of development they became similar in all respects to secondary prothallia produced in the culture. A most convincing instance of the transformation of an antheridium is represented by FIG. 12. The antherozoid cells can still be distinguished. The sterile cells by a number of di-

visions have produced a small prothallium which has already formed a rhizoid.

A number of antheridia were observed in which there was an unusual number of cells as is represented by FIG. 13. The lower portion (*a*) of this antheridium is peculiar since there was present an additional ring cell.

ARCHEGONIA

The frequent occurrence of secondary prothallia among the archegonia suggested that some of them may have originated from these sex-organs. By a careful examination of the prothallia, this idea was confirmed. Frequently prothallial filaments were produced from the neck and the venter cells, especially from the latter. FIG. 14 represents a filament of a number of cells which has arisen from a single neck cell. An early stage in the development of a prothallium from a venter cell is represented by TEXT FIG. 2. The archegonium which had opened in this instance bore an egg (*e*) which had disintegrated. The filaments produced from the archegonia often grew to a considerable length and invariably developed numerous antheridia (TEXT FIG. 3). Frequently plates of cells instead of prothallial filaments were developed from the archegonia (FIGS. 15 and 17).

FIG. 2. A section of a young prothallium of *Polypodium irioides* produced from the venter of an archegonium. × 200.

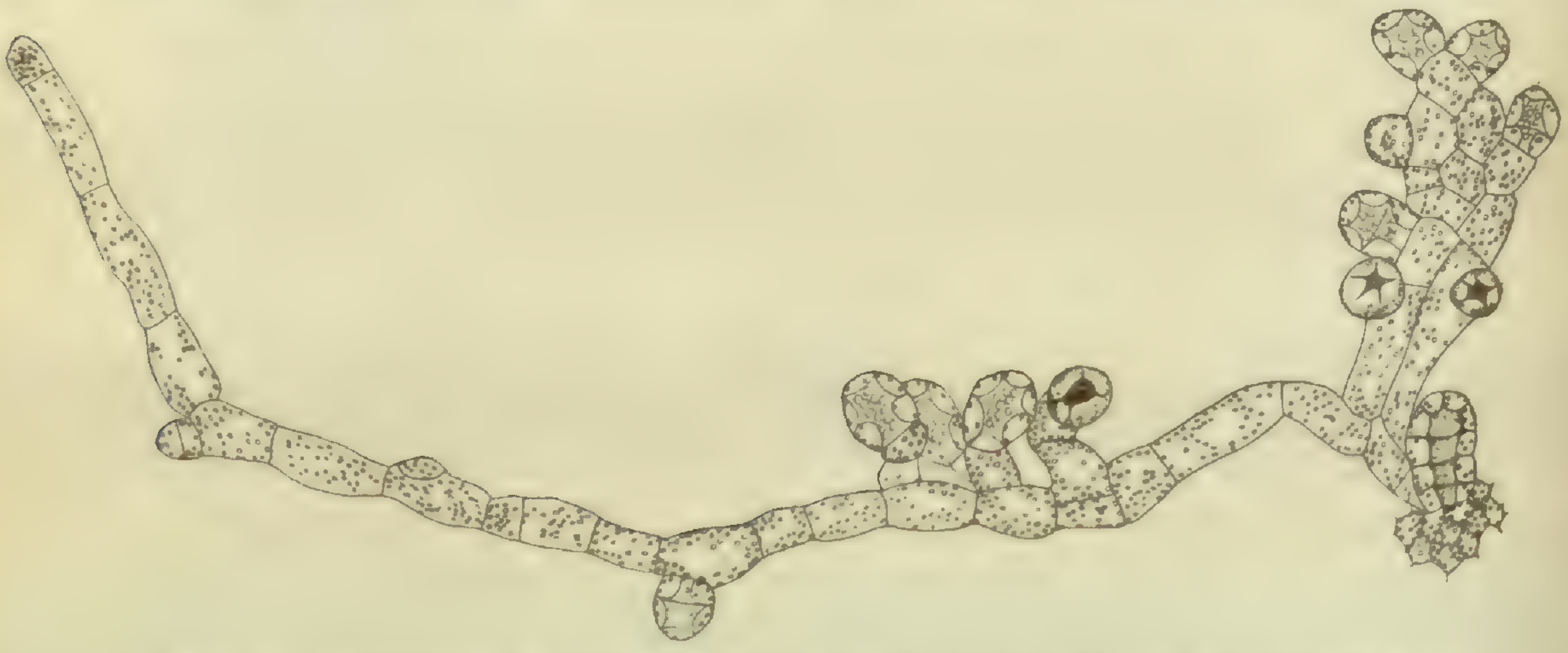

FIG. 3. Regeneration from the venter of anarchegonium of *Polypodium irioide*. Numerous antheridia have been produced by the prothallial filaments. × 100.

From the neck cells of these abnormal archegonia antheridia were also produced. Such antheridia were normal in development (FIGS. 15 and 16). The antheridia thus produced also developed secondary ones (FIG. 16, *b*).

The archegonia at no time were found to develop secondary archegonia. The transformation of archegonia into prothallia was never observed. In these two respects the archegonia differed in behavior from the antheridia.

The archegonia with the behavior just described were like the antheridia, vegetative in nature, numerous chloroplasts being present in the sterile cells. The axial row of cells of the archegonia from which regeneration occurred frequently disintegrated before the archegonia opened. Such a stage is represented by TEXT FIG. 4. It will be observed that some of the neck cells in this case have already divided (*a*, *c*).

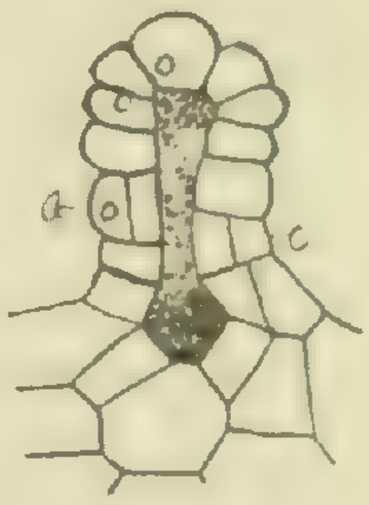

FIG. 4. An archegonium of *Polypodium irioides* in which the axial row of cells has disintegrated. Dividing cells at *a* and *c*. × 200.

CULTURAL CONDITIONS

It is impossible to state under what cultural conditions the sex-organs of *Polypodium irioides* regenerated in the manner described. Since no abnormalities appeared in the early history of the culture, it is probable that the peculiar behavior of the antheridia and the archegonia was the result of unfavorable conditions which appeared in the old culture.

DISCUSSION

No case of regeneration from the sex-organs of a pteridophyte has been previously reported. In the mosses Correns* and Collins† (1919) described the formation of protonemata from the antheridia of *Funaria hygrometrica* (L.) Schreb. Miss Brown‡ found in the same species that protonemata could be induced to form also from the archegonia. In no instance, however, has the formation of antheridia been observed from *either* sex-organ of *any bryophyte*.

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* Correns, Carl. Untersuchungen über die Vermehrung der Laubmoose durch Brutorgane und Stecklinge. Jena. 1899.

† Collins, E. J. Sex segregation in the Bryophyta. Jour. Genetics **8**: 139–146. 1919.

‡ Brown, Mabel Mary. Unpublished paper.

SUMMARY

In an old culture of prothallia of *Polypodium irioides*, the sterile cells of a large number of antheridia and archegonia became vegetative like ordinary prothallial cells.

The lid and the ring cells of the antheridia produced prothallial filaments and secondary antheridia.

The archegonia produced similarly from the neck and the venter cells filaments and antheridia, but in no case secondary archegonia.

At some time during their course of development, antheridia were transformed into prothallia. No such transformations were observed to occur among the archegonia.

The prothallia produced from the sex-organs resembled those formed from the germination of a spore.

Secondary antheridia arising from antheridia and archegonia developed actively motile antherozoids.

Unusual cultural conditions probably diverted the sex-organs of *Polypodium irioides* from their normal course of development.

No similar case of regeneration has been previously reported in a *pteridophyte*.

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Explanation of plate 4

FIG. 1. Antheridia of *Polypodium irioides* Poir.; the lower one with a vegetative ring cell, the upper one with a prothallial filament of two cells produced by a ring cell. × 200.

FIG. 2. An antheridium from the lid cell of which has been produced a filament of four cells. The upper ring cell with a secondary antheridium from which the antherozoids have escaped. × 200.

FIG. 3. The lid cell (*a*) of an antheridium has formed two antheridia (*b* and *c*) from the lid cell of the latter of which another antheridium has been produced. × 230

FIG. 4. Two secondary antheridia produced from a single ring cell of an antheridium. × 230.

FIG. 5. An antheridium-like structure produced from the upper ring cell. × 230.

FIG. 6. The upper ring cell has divided and from one of the cells another antheridium has been developed. × 200.

FIG. 7. An antheridium whose central cells have disintegrated. The sterile cells contain numerous chloroplasts. × 200.

FIG. 8. An antheridium similar to the above. × 393½.

FIG. 9. A normal (*a*) and an abnormal (*b*) antheridium. The upper portion of the latter is disintegrating. × 393½.

FIG. 10. A stage in the transformation of an antheridium into a prothallium. × 200.

FIG. 11. A young prothallium produced by the transformation of an antheridium. × 200.

FIG. 12. A small prothallium similar to above. Antherozoids present. × 200.

FIG. 13. An antheridium with three ring cells. × 200.

FIG. 14. A prothallial filament formed from the neck of an archegonium. × 230.

FIG. 15. Antheridia and a small prothallium produced from the neck of an archegonium. × 200.

FIG. 16. An antheridium (*a*) developed from the neck of an archegonium. From this antheridium a secondary antheridium (*b*) has been formed. × 200.

FIG. 17. A plate of cells produced from the neck of an archegonium. Two normal antheridia have been formed from the prothallial plate. × 200.

INDEX TO AMERICAN BOTANICAL LITERATURE

1911–1921

The aim of this Index is to include all current botanical literature written by Americans, published in America, or based upon American material; the word America being used in the broadest sense.

Reviews, and papers that relate exclusively to forestry, agriculture, horticulture, manufactured products of vegetable origin, or laboratory methods are not included, and no attempt is made to index the literature of bacteriology. An occasional exception is made in favor of some paper appearing in an American periodical which is devoted wholly to botany. Reprints are not mentioned unless they differ from the original in some important particular. If users of the Index will call the attention of the editor to errors or omissions, their kindness will be appreciated.

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Rehder, A. Myrsinaceae. In Sargent, C. S., Plantae Wilsonianae **2**: 580–585. 30 Mr 1916.

Rehder, A. *Neillia*. In Sargent, C. S., Plantae Wilsonianae **1**: 434–437. 15 My 1913.

Rehder, A. Oleaceae. In Sargent, C. S., Plantae Wilsonianae **2**: 600–616. 30 Mr 1916.

Rehder, A. *Pilostegia*. In Sargent, C. S., Plantae Wilsonianae **1**: 151. 30 Ap 1912.

Rehder, A. *Ribes*. In Sargent, C. S., Plantae Wilsonianae **1**: 152, 153. 30 Ap 1912.

Rehder, A. Rosaceae, Subfam. Pomoideae. In Sargent, C. S., Plantae Wilsonianae **2**: 263–300. 28 D 1915.

Rehder, A. Rosaceae, Subfam. Prunoideae. In Sargent, C. S., Plantae Wilsonianae **2**: 344, 345. 28 D 1915.

Rehder, A. *Schizophragma*. In Sargent, C. S., Plantae Wilsonianae **1**: 41–43. 31 Jl 1911.

Rehder, A. Scrophulariaceae. In Sargent, C. S., Plantae Wilsonianae **1**: 573–578. 15 My 1913.

Rehder, A. *Sibiraea.* In Sargent, C. S., Plantae Wilsonianae 1: 455, 456. 15 My 1913.

Rehder, A. *Sorbaria.* In Sargent, C. S., Plantae Wilsonianae 1: 47, 48. 31 Jl 1911.

Rehder, A. *Spiraea.* In Sargent, C. S., Plantae Wilsonianae 1: 438–455. 15 My 1913.

Rehder, A. Stachyuraceae. In Sargent, C. S., Plantae Wilsonianae 1: 287, 288. 30 Ap 1912.

Rehder, A. *Stephanandra.* In Sargent, C. S., Plantae Wilsonianae 1: 437. 15 My 1913.

Rehder, A. Styracaceae. In Sargent, C. S., Plantae Wilsonianae 1: 289–296. 30 Ap 1912.

Rehder, A. Symplocaceae. In Sargent, C. S., Plantae Wilsonianae 2: 593–599. 30 Mr 1916.

Rehder, A. Tamaricaceae. In Sargent, C. S., Plantae Wilsonianae 2: 406, 407. 28 D 1915.

Rehder, A. Thymelaeaceae. In Sargent, C. S., Plantae Wilsonianae 2: 530–551. 30 Mr 1916.

Rehder, A. Verbenaceae. In Sargent, C. S., Plantae Wilsonianae 3: 366–379. 31 Au 1916.

Rehder, A., & Wilson, E. H. Anacardiaceae. In Sargent, C. S., Plantae Wilsonianae 2: 172–184. 24 Mr 1914.

Rehder, A., & Wilson, E. H. Aristolochiaceae. In Sargent, C. S., Plantae Wilsonianae 3: 323, 324. 31 Au 1916.

Rehder, A., & Wilson, E. H. Burseraceae. In Sargent, C. S., Plantae Wilsonianae 2: 155. 24 Mr 1914.

Rehder, A., & Wilson, E. H. Buxaceae. In Sargent, C. S., Plantae Wilsonianae 2: 163–169. 24 Mr 1914.

Rehder, A., & Wilson, E. H. Calycanthaceae. In Sargent, C. S., Plantae Wilsonianae 1: 419, 420. 15 My 1913.

Rehder, A., & Wilson, E. H. Celastraceae. In Sargent, C. S., Plantae Wilsonianae 2: 346–359. 28 D 1915.

Rehder, A., & Wilson, E. H. Cercidiphyllaceae. In Sargent, C. S., Plantae Wilsonianae 1: 316, 317. 15 My 1913.

Rehder, A., & Wilson, E. H. Clethraceae. In Sargent, C. S., Plantae Wilsonianae 1: 501, 502. 15 My 1913.

Rehder, A., & Wilson, E. H. Coriariaceae. In Sargent, C. S., Plantae Wilsonianae 2: 170, 171. 24 Mr 1914.

Rehder, A., & Wilson, E. H. *Cotoneaster.* In Sargent, C. S., Plantae Wilsonianae 1: 154–177. 30 Ap 1912.

Rehder, A., & Wilson, E. H. Ebenaceae. In Sargent, C. S., Plantae Wilsonianae 2: 587–592. 30 Mr 1916.

Rehder, A., & Wilson, E. H. Elaeocarpaceae. In Sargent, C. S., Plantae Wilsonianae 2: 360–362. 28 D 1915.

Rehder, A., & Wilson, E. H. Ericaceae. In Sargent, C. S., Plantae Wilsonianae 1: 503–562. 15 My 1913.

Rehder, A., & Wilson, E. H. *Eriobotrya.* In Sargent, C. S., Plantae Wilsonianae 1: 193–195. 30 Ap 1912.

Rehder, A., & Wilson, E. H. Fagaceae. In Sargent, C. S., Plantae Wilsonianae 2: 190–237. 31 Au 1916.

Rehder, A., & Wilson, E. H. Ginkgoaceae. In Sargent, C. S., Plantae Wilsonianae 2: 1, 2. 24 Mr 1914.

Rehder, A., & Wilson, E. H. Hamamelidaceae. In Sargent, C. S., Plantae Wilsonianae 1: 421–432. 15 My 1913.

Rehder, A., & Wilson, E. H. Icacinaceae. In Sargent, C. S., Plantae Wilsonianae 2: 190. 24 Mr 1914.

Rehder, A., & Wilson, E. H. Juglandaceae. In Sargent, C. S., Plantae Wilsonianae 3: 180–188. 8 My 1916.

Rehder, A., & Wilson, E. H. Lardizabalaceae. In Sargent, C. S., Plantae Wilsonianae 1: 344–352. 15 My 1913.

Rehder, A., & Wilson, E. H. Loganiaceae. In Sargent, C. S., Plantae Wilsonianae 1: 563–572. 15 My 1913.

Rehder, A., & Wilson, E. H. Lythraceae. In Sargent, C. S., Plantae Wilsonianae 2: 418. 28 D 1915.

Rehder, A., & Wilson, E. H. Magnoliaceae. In Sargent, C. S., Plantae Wilsonianae 1: 391–418. 15 My 1913.

Rehder, A., & Wilson, E. H. Malvaceae. In Sargent, C. S., Plantae Wilsonianae 2: 373–375. 28 D 1915.

Rehder, A., & Wilson, E. H. Melastomataceae. In Sargent, C. S., Plantae Wilsonianae 2: 421, 422. 28 D 1915.

Rehder, A., & Wilson, E. H. Meliaceae. In Sargent, C. S., Plantae Wilsonianae 2: 156–159. 24 Mr 1914.

Rehder, A., & Wilson, E. H. Menispermaceae. In Sargent, C. S., Plantae Wilsonianae 1: 387–390. 15 My 1913.

Rehder, A., & Wilson, E. H. Myrtaceae. In Sargent, C. S., Plantae Wilsonianae 2: 420. 28 D 1915.

Rehder, A., & Wilson, E. H. Passifloraceae. In Sargent, C. S., Plantae Wilsonianae **2**: 408. 28 D 1915.

Rehder, A., & Wilson, E. H. *Photinia*. In Sargent, C. S., Plantae Wilsonianae **1**: 184–192. 30 Ap 1912.

Rehder, A., & Wilson, E. H. Pinaceae. In Sargent, C. S., Plantae Wilsonianae **2**: 10–62. 24 Mr 1914.

Rehder, A., & Wilson, E. H. Pittosporaceae. In Sargent, C. S., Plantae Wilsonianae **3**: 326–330. 31 Au 1916.

Rehder, A., & Wilson, E. H. Polygalaceae. In Sargent, C. S., Plantae Wilsonianae **2**: 160–162. 24 Mr 1914.

Rehder, A., & Wilson, E. H. Punicaceae. In Sargent, C. S., Plantae Wilsonianae **2**: 419. 28 D 1915.

Rehder, A., & Wilson, E. H. Ranunculaceae. In Sargent, C. S., Plantae Wilsonianae **1**: 318–343. 15 My 1913.

Rehder, A., & Wilson, E. H. Rosaceae, Subfam. Rosoideae. In Sargent, C. S., Plantae Wilsonianae **2**: 300–344. 28 D 1915.

Rehder, A., & Wilson, E. H. Rutaceae. In Sargent, C. S., Plantae Wilsonianae **2**: 121–151. 24 My 1914.

Rehder, A., & Wilson, E. H. Sabiaceae. In Sargent, C. S., Plantae Wilsonianae **2**: 195–208. 24 Mr 1914.

Rehder, A., & Wilson, E. H. Sapindaceae. In Sargent, C. S., Plantae Wilsonianae **2**: 191–194. 24 Mr 1914.

Rehder, A., & Wilson, E. H. Simarubaceae. In Sargent, C. S., Plantae Wilsonianae **2**: 152–154. 24 Mr 1914.

Rehder, A., & Wilson, E. H. Staphyleaceae. In Sargent, C. S., Plantae Wilsonianae **2**: 185–189. 24 Mr 1914.

Rehder, A., & Wilson, E. H. Sterculiaceae. In Sargent, C. S., Plantae Wilsonianae **2**: 376, 377. 28 D 1915.

Rehder, A., & Wilson, E. H. *Stranvaesia*. In Sargent, C. S., Plantae Wilsonianae **1**: 192, 193. 30 Ap 1912.

Rehder, A., & Wilson, E. H. Taxaceae. In Sargent, C. S., Plantae Wilsonianae **2**: 3–9. 24 Mr 1914.

Rehder, A., & Wilson, E. H. Theaceae. In Sargent, C. S., Plantae Wilsonianae **2**: 390–401. 28 D 1915.

Rehder, A., & Wilson, E. H. Tiliaceae. In Sargent, C. S., Plantae Wilsonianae **2**: 363–372. 28 D 1915.

Rehder, A., & Wilson, E. H. Trochodendraceae. In Sargent, C. S., Plantae Wilsonianae **1**: 313–315. 15 My 1913.

Rehder, A., & Wilson, E. H. *Wistaria.* In Sargent, C. S., Plantae Wilsonianae **2**: 509–515. 30 Mr 1916.

Rehder, A., & Wilson, E. H. Zygophyllaceae. In Sargent, C. S., Plantae Wilsonianae **2**: 120. 24 Mr 1914.

Rendle, A. B. Gramineae. In Sargent, C. S., Plantae Wilsonianae **2**: 63–65. 24 Mr 1914.

Sargent, C. S. *Carya.* In Sargent, C. S., Plantae Wilsonianae **3**: 187, 188. 8 My 1916.

Sargent, C. S. *Crataegus.* In Sargent, C. S., Plantae Wilsonianae **1**: 178–183. 30 Ap 1912.

Sargent, C. S. *Phellodendron.* In Sargent, C. S., Plantae Wilsonianae **2**: 136, 137. 24 Mr 1914.

Schindler, A. K. *Campylotropis.* In Sargent, C. S., Plantae Wilsonianae **2**: 113–115. 24 Mr 1914.

Schindler, A. K. *Lespedeza.* In Sargent, C. S., Plantae Wilsonianae **2**: 105–112. 24 Mr 1914.

Schneider, C. Apocynaceae. In Sargent, C. S., Plantae Wilsonianae **3**: 331–342. 31 Au 1916.

Schneider, C. Asclepiadaceae. In Sargent, C. S., Plantae Wilsonianae **3**: 343–354. 31 Au 1916.

Schneider, C. Berberidaceae. In Sargent, C. S., Plantae Wilsonianae **1**: 353–386. 15 My 1913.

Schneider, C. Betulaceae. In Sargent, C. S., Plantae Wilsonianae **2**: 423–508. 30 Mr 1916.

Schneider, C. Compositae. In Sargent, C. S., Plantae Wilsonianae **3**: 418, 419. 31 Au 1916.

Schneider, C. Convolvulaceae. In Sargent, C. S., Plantae Wilsonianae **3**: 355–362. 31 Au 1916.

Schneider, C. Moraceae. In Sargent, C. S., Plantae Wilsonianae **3**: 292–311. 31 Au 1916.

Schneider, C. Olacaceae. In Sargent, C. S., Plantae Wilsonianae **3**: 321, 322. 31 Au 1916.

Schneider, C. Polygonaceae. In Sargent, C. S., Plantae Wilsonianae **3**: 325. 31 Au 1916.

Schneider, C. Rhamnaceae. In Sargent, C. S., Plantae Wilsonianae **2**: 209–253. 24 Mr 1914.

Schneider, C. Salicaceae. In Sargent, C. S., Plantae Wilsonianae **3**: 16–179. 8 My 1916.

Schneider, C. Santalaceae. In Sargent, C. S., Plantae Wilsonianae **3**: 320. 31 Au 1916.

Schneider, C. Solanaceae. In Sargent, C. S., Plantae Wilsonianae **3**: 385, 386. 31 Au 1916.

Schneider, C. *Syringa*. In Sargent, C. S., Plantae Wilsonianae **1**: 297–301. 30 Ap 1912.

Schneider, C. Ulmaceae. In Sargent, C. S., Plantae Wilsonianae **3**: 238–291. 31 Au 1916.

Schneider, C. Urticaceae. In Sargent, C. S., Plantae Wilsonianae **3**: 312–314. 31 Au 1916.

Shaw, G. R. Pinaceae. In Sargent, C. S., Plantae Wilsonianae **1**: 1–3. 31 Jl 1911; **2**: 10–18. 24 Mr 1914.

Swingle, W. T. *Citrus*. In Sargent, C. S., Plantae Wilsonianae **2**: 141–149. 24 Mr 1914.

Swingle, W. T. *Poncirus*. In Sargent, C. S., Plantae Wilsonianae **2**: 149–151. 24 Mr 1914.

Takeda, H. *Cladrastis*. In Sargent, C. S., Plantae Wilsonianae **2**: 97, 98. 24 Mr 1914.

Takeda, H. *Maackia*. In Sargent, C. S., Plantae Wilsonianae **2**: 98, 99. 24 Mr 1921.

Wilson, E. H. The "Indian Azaleas" at Magnolia Gardens [South Carolina]. Jour. Arnold Arbor. **2**: 159, 160. 1921.

Wilson, E. H., & Rehder, A. A monograph of Azaleas. [*Rhododendron* subgenus *Anthodendron*.] Publ. Arnold Arb. 9: 1–219. 15 Ap 1921.

Includes *Rhododendron alabamense* sp. nov. from Alabama.

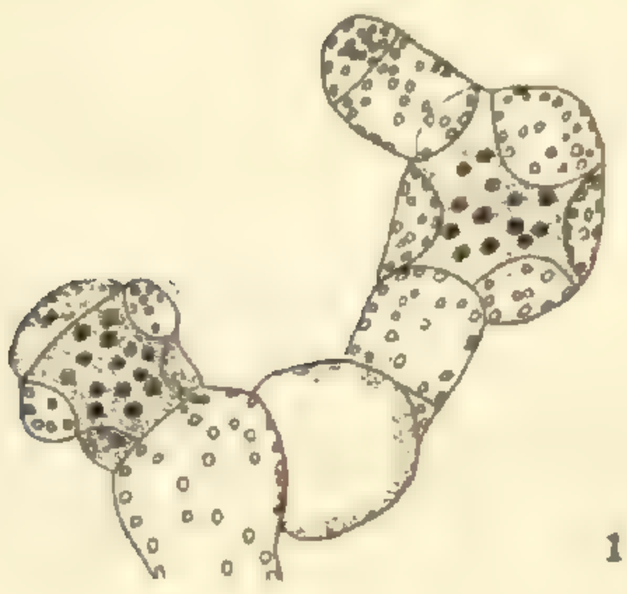
Youngken, H. W. Hybridization in plants. Am. Jour. Phar. **93**: 249–254. Ap 1921.

Yuncker, T. G. Revision of the North American and West Indian species of *Cuscuta*. Illinois Biol. Monogr. **6**: n. 2, 3: 1–141. *pl. 1–12*. 1 Mr 1921.

Zillig, H. Unsere heutigen Kenntnisse von der Verbreitung des Antherenbrandes (*Ustilago violacea* (Pers). Fuck.). Ann. Mycol. **18**: 136–153. Ap 1921.

Zinn, J. Normal and abnormal germination of grass-fruits. Bull. Maine Agr. Exp. Sta. 294: 197–216. *f. 35–43*. D 1920.

Abstract from a German paper by the author in Mitteil. Landw. Lehrk. Hochsch. Bodenkultur **2**: 675–712. 1914.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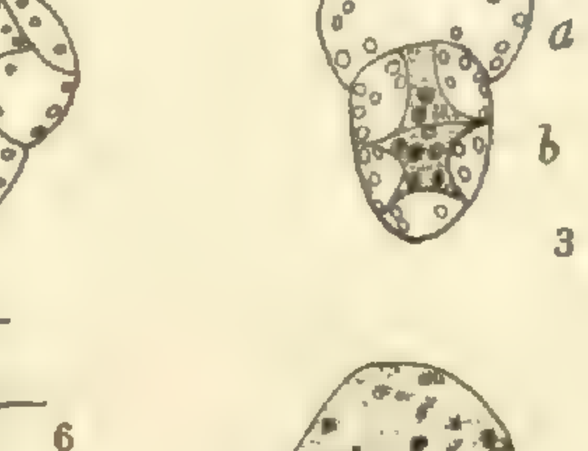
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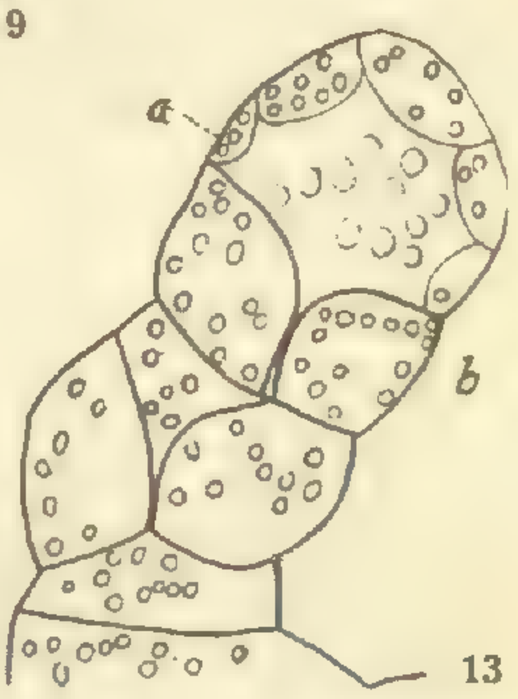
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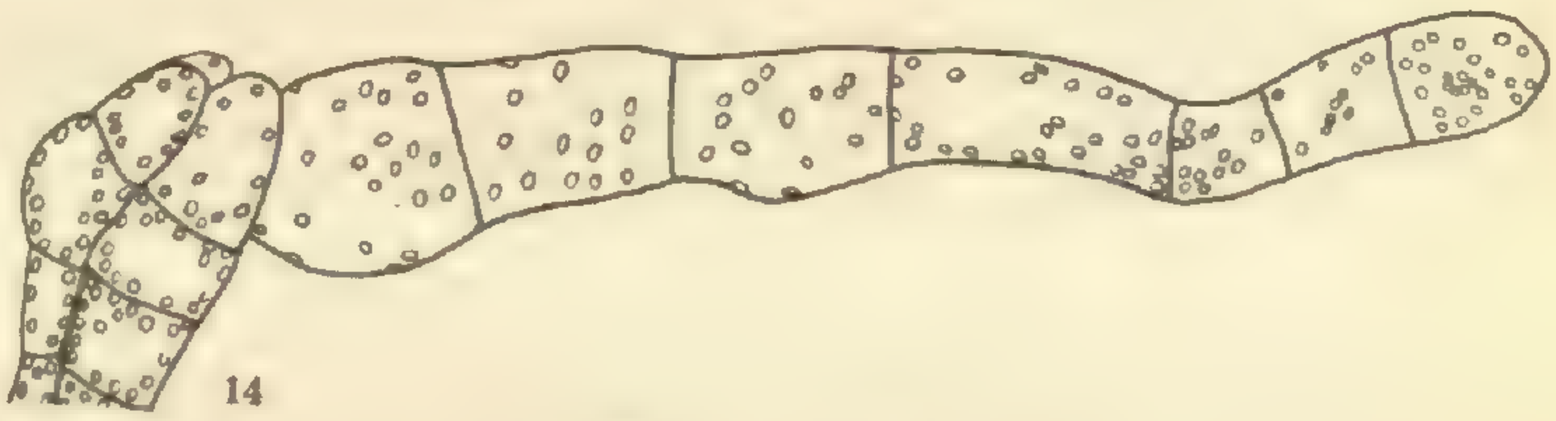
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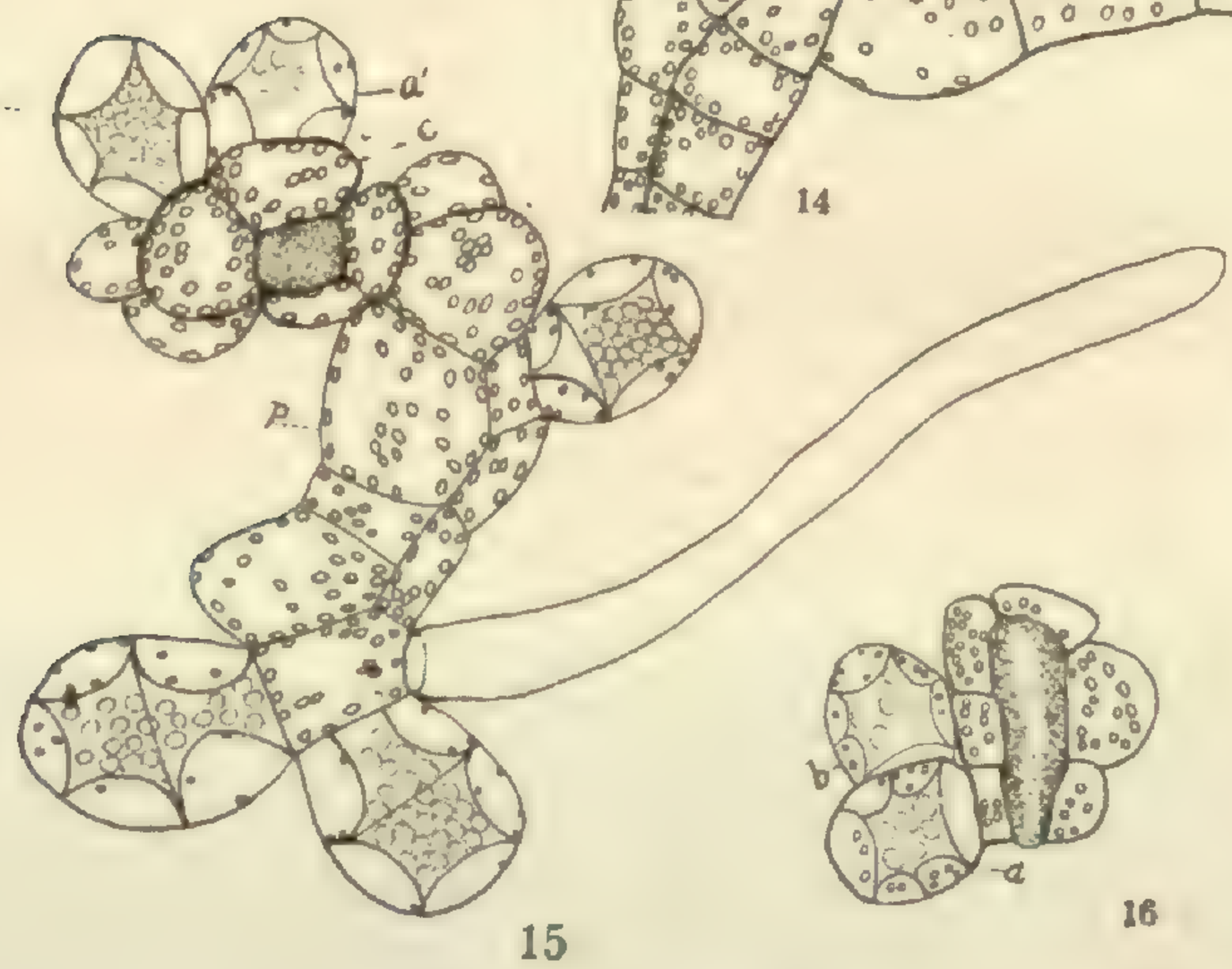
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STEIL : POLYPODIUM IRIOIDES

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Philippine Basidiomycetes—IV

PAUL W. GRAFF

The following pages are presented in continuation of papers already published* on the basidiomycetous flora of the Philippine Archipelago. The fungous flora of the tropics is proving to be much more extensive than had previously been imagined, and the range of many species found to be much wider than formerly supposed. In a few instances species already reported from the Islands have been included for the sake of correction in name, extension of synonymy, and distribution. The value of range-notes is becoming more and more evident when the extension rather than the diminishing area of habitats is noticed. No new species will be found described in this paper, a fact which will doubtless be interpreted by some as a loss of golden opportunity. The identification of species already described and but imperfectly known seems to the writer more important than searching for minor differences as an excuse for creating new plant names and more confusion.

POLYPOREAE

POLYPORUS Micheli

POLYPORUS GILVUS (Schwein.) Fr. Elench. Fung. 104. 1828.

Boletus gilvus Schwein. Syn. Fung. Carol. 897. 1822.

Boletus impuber Sowerb. Engl. Fungi. *pl. 195*. 1799.

* Additions to the basidiomycetous flora of the Philippines. Philip. Jour. Sci. **8**: (Bot.) 299–309. *pl. 8–10*. 1913; Philippine Basidiomycetes —II. Philip. Jour. Sci. **9**: (Bot.) 235–255. *pl. 2*. 1914; Philippine Basidiomycetes—III. Bull. Torrey Club **45**: 451–469. *pl. 15*. 1918.

[The BULLETIN for October (**48**: 263–284. *pl. 4*) was issued December 31, 1921.]

LUZON: Province of Laguna, San Pablo, March, 1913, *P. W. Graff, Bur. Sci. 21052*, on decaying log.

A fungus of rather general tropical, and warm north temperate distribution.

POLYPORUS MARIANNUS Pers.; Gaudichaud, Bot. Voy. Uranie 173. 1826.

Polyporus anebus Berk. Jour. Bot. **6**: 504. 1847.

LUZON: Province of Laguna, Los Baños, October, 1912, *Baker 297*, growing on decaying wood in the forest.

This species was first described by Persoon from material collected by Gaudichaud-Beaupré, of the Freycinet Expedition, on his visit to Guam in the Marianne Islands during the month of March, 1819. It has been considered by Schumann and Lauterbach* as a synonym of *Polyporus Kamphoveneri*, and by Murrill† as identical with *P. corrugatus*, originally described by Persoon from material collected at the same locality and time. It seems, however, that the material preserved in the Paris Museum tallies more closely with Berkeley's species, *P. anebus*, from Ceylon than with either of these two.

As far as at present known the species range includes Africa, Ceylon, Japan and numerous islands of the Pacific.

POLYPORUS OSTREIFORMIS Berk. Jour. Linn. Soc. Bot. **16**: 46. 1878.

LUZON: vicinity of Manila, October, 1912, *P. W. Graff, Bur. Sci. 16795*, growing from a wound on *Enterolobium Saman* (*Pithecolobium*).

This collection is of interest as being the first made since the type material was gathered by the "Challenger Expedition" in February, 1875. The color of both upper and lower surface is a grey-white and the fungus has a slightly foetid odor when fresh.

The species has been collected only in the Philippines.

POLYPORUS RHODOPHOEUS Lév. Ann. Sci. Nat. Bot. III. **2**: 190. 1844.

Polyporus cinereo-fuscus Curr. Ind. Fung. 142. 1874.

Polyporus zonalis Berk. var. *semilaccatus* Berk. Jour. Linn. Soc. Bot. **16**: 46. 1878.

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* Die Flora der Deutschen Schutzgebiet in der Südsee, 1–613. *pl. 1–22*. 1901.

† Bull. Torrey Club **34**: 468. 1907.

Fomes semilaccatus Berk. Grevillea **15**: 22. 1886.
Coriolopsis semilaccata Murr. Bull. Torrey Club **34**: 466. 1907.

LUZON: Province of Laguna, Mount Maquiling, February, 1912, *P. W. Graff*, *Bur. Sci. 15936*, on decaying tree branches.

A fungus of very general tropical distribution. It is found both in the American and Asiatic tropics and on the islands of the Pacific.

POLYPORUS RUBIDUS Berk. Jour. Bot. **6**: 500. 1847.

LUZON: Province of Laguna, Mount Maquiling, February, 1912, *P. W. Graff*, *Bur. Sci. 16024*, on fallen and decaying timber.

This species is closely related to *Fomes roseus* (Alb. & Schw.) Cooke, which appears to be of a much broader tropical distribution. It may be that the latter is but a perennial form of the present species, a condition induced by certain tropical environmental factors and occurring in a number of other tropical forms.

Collected previously on the island of Ceylon.

POLYPORUS ZONALIS (Konig) Berk. Jour. Bot. **6**: 504. 1847.

Boletus zonalis Konig, Ann. Mag. Nat. Hist. **10**: 375. *pl. 10, f. 5*. 1846.
Polyporus plumbeus Lév. Ann. Sci. Nat. Bot. III. **5**: 136. 1846.
Polyporus rufo-pictus Berk. & Curt. Grevillea **15**: 23. 1886.

LUZON: vicinity of Manila, August, 1913, *Sanchez 29*.

Reported as having been collected in Cuba, Guiana, Java, and Ceylon.

GANODERMA Karsten

GANODERMA AMBOINENSE (Lam.) Pat. Bull. Soc. Myc. Fr. **5**: 70. 1889.

Fungus digitatus Rumph. Herb. Amb. **6**: 128. *pl. 57, f. 2, 3*. 1755.
Fungus elatus-coclearis Rumph. Herb. Amb. **6**: 128. *pl. 57, f. 1*. 1755.
Agaricus amboinensis Lam. Enc. Méth. Bot. **1**: 49. 1783.
Polyporus japonicus Thunb. Flor. japon. 348. 1784. Not Fries.
Polyporus amboinensis Fr. Syst. Myc. **1**: 354. 1821.
Polyporus fornicatus Fr. Epicr. Myc. 443. 1836.
Polyporus lingua Nees, Nov. Act. Acad. Nat. Cur. **13**: 15. *pl. 3*. 1837.

Polyporus gibbosus Nees, Nov. Act. Acad. Nat. Cur. **13**: 19. *pl. 5.* 1837.

Polyporus coclear Nees, Nov. Act. Acad. Nat. Cur. **13**: 20. *pl. 6.* 1837.

Fomes lingua Sacc. Syll. Fung. **6**: 156. 1888.

Ganoderma amboinense forma *lingua* Pat. Philip. Jour. Sci. **10**: (Bot.) 96. **1915.**

LUZON: Province of Laguna, Mount Maquiling, April, 1913, *P. W. Graff, Bur. Sci. 21014*, on decaying log at 500 m. elevation. POLILLO: Province of Tayabas, Mount Malulud, August, 1909, *C. B. Robinson, Bur. Sci. 9101*, at an elevation of 300 m.; same locality, October–November, 1909, *R. C. McGregor, Bur. Sci. 10534.*

This fungus is so variable in the shapes it may assume that it is not surprising the earlier workers described it under a number of names. The writer has seen it growing in a great variety of forms, varying from those having a pileus of considerable size and almost lacking a stipe to forms growing from cracks and holes of decaying logs which had a long slender stipe and a very small fruiting end of no greater diameter than the stipe itself. Branching forms also are occasionally found. An interesting example of one of these branched specimens was found in a Negrito village by one of the Jesuit Fathers, and brought by him to Manila. The specimen had developed five branches and the similarity in shape to a hand was very striking. At the point of branching the fungus had spread in such a manner as to resemble the palm, while the five branches were each tipped with fruiting surfaces, which being lighter in color thus formed the finger nails. The natives of the village had found this specimen in the forest and brought it in on their return. Such a remarkable thing as a hand reaching out of a tree was to them *anting-anting* or supernatural, and the object was being worshiped by these superstitious people.

Such specific names as have been given to this plant at various times, as *digitatus*, *elatus-cochlearis*, *coclear*, and *lingua*, give some suggestion of the shapes the plant may assume. It is no wonder that, without available material for comparison, botanists of different countries should each have described this under his own name.

This species has been found in the tropics of South America, the Pacific islands, and Japan.

GANODERMA ELMERIANUM (Murr.) Sacc. & Trott.; Saccardo, Syll. Fung. **21**: 305. 1912.

Amauroderma Elmerianum Murr. Bull. Torrey Club **34**: 475. 1907.

LUZON: Province of Bataan, Mount Mariveles, November, 1904, *Elmer 6906*. LEYTE: Palo, January, 1906, *Elmer 7210*, on dead and decaying tree stumps.

As yet only reported from the Philippines.

Ganoderma leptopum (Pers.) comb. nov.

Polyporus leptopus Pers.; Gaudichaud, Bot. Voy. Uranie 169. *pl. 2, f. 2.* 1826.

Polyporus umbraculum Fr. Elench. Fung. 74. 1828. Not Thüm.

Fomes umbraculum Sacc. Syll. Fung. **6**: 159. 1888.

Ganoderma umbraculum Pat. Bull. Soc. Myc. France **5**: 75. 1889.

Ganoderma subrugosum Bres. & Pat. Bull. Soc. Myc. France **5**: 77. *pl. 10, f. 1.* 1889.

Ganoderma Curranii Murr. Bull. Torrey Club **35**: 411. 1908.

This species was first collected in the Philippines by Dr. H. M. Curran in the forest on Mount Mariveles, Bataan Province, Luzon, and described as a new species, *Ganoderma Curranii*, by Murrill. The fungus was originally described by Persoon from material collected by Gaudichaud-Beaupré on the island of Rawak, and shortly after redescribed by Fries from material collected by Afzelius in Sierra Leone. Later Bresadola and Patouillard described and figured the species from Samoan material and suggested its possible identity with *Polyporus rugosus* var. *guineensis* Fr. The plates of both Persoon and Patouillard give an excellent idea of the fungus, which belongs to the *Amauroderma* section of the genus *Ganoderma*.

GANODERMA TORNATUM (Pers.) Bres. Hedwigia **53**: 55. 1912.

Polyporus tornatus Pers.; Gaudichaud, Bot. Voy. Uranie 173. 1826.

Polyporus australis Fr. Elench. Fung. 108. 1828.

Fomes australis Cooke, Grevillea **14**: 18. 1885.

Ganoderma australe Pat. Bull. Soc. Myc. Fr. **5**: 71. 1889.

Elfvingia tornata Murr. Bull. Torrey Club **30**: 301. 1903.

LUZON: Province of Nueva Vizcaya, vicinity of Dupax, March–April, 1912, *R. C. McGregor, Bur. Sci. 14376*, on decaying timber; Province of Laguna, Mount Maquiling, February, 1912, *W. H. Brown, Bur. Sci. 16033, 16039.*

This species is of general tropical distribution, being found in both the American and Asiatic tropics.

Ganoderma tornatum var. **subtornatum** (Murr.) comb. nov.

Ganoderma subtornatum Murr. Bull. Torrey Club **34**: 477. 1907.

LUZON: Province of Laguna, Mount Maquiling, February, 1912, *P. W. Graff, Bur. Sci. 16025.*

As yet this variety has been reported only from the Philippines, and has been collected there only on the islands of Luzon and Leyte. The type was found on the Lamao River, Province of Bataan, by R. S. Williams in 1903. The variety differs from the species in the greater amount of resinous material in its composition, hardly a specific distinction though causing a slight difference in the appearance of its texture.

FOMES Fries

FOMES EXOTOPHRUS Berk. Jour. Linn. Soc. Bot. **16**: 49. 1878.

LUZON: Province of Laguna, Mount Maquiling, February, 1912, *P. W. Graff, Bur. Sci. 16009*, also April 12, 1913. *P. W. Graff, Bur. Sci. 21031*, on fallen tree branches at 150 m. elevation.

This species was described from material collected in the Admiralty Islands by the Challenger Expedition and is still known only from those islands and the Philippines.

FOMES ENDOTHEIUS (Berk.) Sacc. Syll. Fung. **6**: 187. 1888.

Polyporus endothejus Berk. Jour. Linn. Soc. Bot. **16**: 47. 1878.

Pyropolyporus endotheius Murr. Bull. Torrey Club **34**: 478. 1907.

CULION: December, 1902, *Merrill 3575*.

Originally described by Berkeley from Philippine material collected by the Challenger Expedition in 1875, and as yet not found outside these islands.

FOMES LAMAENSIS (Murr.) Sacc. & Trott; Saccardo, Syll. Fung. **21**: 287. 1912.

Pyropolyporus lamaensis Murr. Bull. Torrey Club **34**: 479. 1907.

Pyropolyporus Williamsii Murr. Bull. Torrey Club **34**: 479. 1907.

Fomes Williamsii Sacc. & Trott.; Saccardo, Syll. Fung. **21**: 289. 1912.

Phellinus Williamsii Pat. Leafl. Philip. Bot. **6**: 2249. 1914.

LUZON, Province of Tayabas, Kabibihan, March, 1911, *F. W. Foxworthy, Bur. Sci. 13155*, on a decaying log.

Of general distribution in the Philippine Islands but, as yet, not reported from elsewhere.

FOMES LINEATUS (Pers.) Graff, Mycologia **9**: 10. 1917.

Polyporus lineatus Pers.; Gaudichaud, Bot. Voy. Uranie 174. 1826.

Polyporus fastuosus Lév.; Gaudichaud, Bot. Voy. Bonite **1**: 180. 1846.

Fomes fastuosus Cooke, Grevillea **14**: 18. 1886.

LUZON: Province of Nueva Vizcaya, vicinity of Dupax, March–April, 1912, *R. C. McGregor, Bur. Sci. 14364;* Province of Bataan, Lamao, November, 1908, *H. M. Curran, For. Bur. 15568.* MINDANAO: Lake Lanao, Camp Keithley, June–July, 1907, *Mary S. Clemens.*

The name *Pyropolyporus fastuosus* as published by Murrill* from Philippine material was applied to *Fomes spadiceus* (Berk.) Cooke instead of to *F. fastuosus* (Lév.) Cooke, as is shown by the duplicate material in the herbarium of the Bureau of Science, Manila. Because of this *Pyropolyporus fastuosus* becomes a synonym of *Fomes spadiceus* rather than of *Fomes lineatus*. Both species of fungus are very common in the Philippines.

Collected in the Philippines, the Moluccas, the Federated Malay States, and the island of Guam.

Fomes Merrittii (Murr.) comb. nov.

Tyromyces Merrittii Murr. Bull. Torrey Club **35**: 406. 1908.

Polyporus Merrittii Sacc. & Trott.; Saccardo, Syll. Fung. **21**: 278. 1912.

* Bull. Torrey Club **34**: 479. 1907.

LUZON: Province of Laguna, Moünt Maquiling, November, 1907, *H. M. Curran & M. L. Merritt, For. Bur. 8939*, on dead wood, host species undetermined.

This species belongs to the genus *Fomes* rather than to *Polyporus*, as considered by Saccardo and Trotter.

As yet reported only from the Philippine Islands.

FOMES PECTINATUS (Klotz.) Gillet, Champ. France **1**: 686. 1878.
Polyporus pectinatus Klotz. Linnaea **8**: 485. 1833.
Polyporus Haskarlii Lév. Ann. Sci. Nat. Bot. III. **2**: 190. 1844.
Polyporus pullus Mont. & Berk. Jour. Bot. **3**: 332. 1844.
Fomes pullus Cooke, Grevillea **14**: 19. 1885.
Pyropolyporus pectinatus Murr. Bull. Torrey Club **34**: 479. 1907.

LUZON: Province of Laguna, Mount Maquiling, February, 1912, *P. W. Graff, Bur. Sci. 15931, 16011;* Province of Bataan, Lamao, September, 1907, *H. M. Curran, For. Bur. 7520.*

Collected in North America, Australia, and the East Indies.

FOMES ROSEO-ALBUS (Jungh.) Bres. Ann. Myc. **8**: 587. 1910.
Poria roseo-alba Jungh. Ann. Sci. Nat. Bot. III. **2**: 194. 1844.
Polyporus roseo-albus Jungh. Plant. Java Crypt. 43. 1845.
Fomes mortuosus Fr. Nov. Symb. Myc. 64. 1851.
Polyporus endapalus Berk. Jour. Linn. Soc. Bot. **13**: 163. 1873.
Polyporus caliginosus Berk. Jour. Linn. Soc. Bot. **16**: 46. 1878.
Pyropolyporus caliginosus Murr. Bull. Torrey Club **34**: 478. 1907.
Coriolopsis Copelandii Murr. Bull. Torrey Club **35**: 392. 1908.
Polystictus Copelandii Sacc. & Trott.; Saccardo, Syll. Fung. **21**: 322. 1912.

MINDANAO: District of Davao, Davao, March, 1904, *Copeland 714* (type of *Coriolopsis Copelandii*); Todaya, April, 1904, *Copeland 1214.*

Of general distribution through the Asiatic tropics and the Pacific islands. Originally described from Javan material.

POLYSTICTUS Fries

POLYSTICTUS AFFINIS (Nees) Fr. Nov. Act. Reg. Soc. Sci. Ups. III. 1: 75. 1855.

Polyporus affinis Nees, Nov. Act. Acad. Nat. Cur. 13[1]: 18. *pl. 4, f. 1.* 1826.

Polyporus lateralis Pers.; Gaudichaud, Bot. Voy. Uranie. Sec. M. 1826.

LUZON: Province of Laguna, Mount Maquiling, February, 1912, *P. W. Graff, Bur. Sci. 15954,* on fallen dead branches; Province of Nueva Vizcaya, vicinity of Dupax, March–April, 1912, *R. C. McGregor, Bur. Sci. 14367,* on decaying logs.

This species belongs to the "*Polystictus perula* group" and, with *P. xanthopus, P. luteus, P. macroloma, P. flabelliformis* and several others, goes to make up a series which is much confused in the literature of tropical fungi. Fortunately, however, while this confusion exists in the identification of these species, none of them are overburdened with synonyms-

Of very common distribution throughout the Asiatic tropics and the East Indies.

POLYSTICTUS BATAANENSIS (Murr.) Sacc. & Trott.; Saccardo, Syll. Fung. 21: 322. 1912.

Coriolopsis bataanensis Murr. Bull. Torrey Club 35: 393. 1908.

LUZON: Province of Bataan, Mount Mariveles, January, 1904, *Copeland 143,* on dead tree branches at 230 m. elevation.

Reported, as yet, only from the Philippines.

POLYSTICTUS CALLIMORPHUS (Lév.) Sacc. Syll. Fung. 6: 277. 1888.

Polyporus callimorphus Lév. Ann. Sci. Nat. Bot. III. 5: 133. 1846.

LUZON: Province of Bataan, Mount Mariveles, November, 1912, *P. W. Graff, Bur. Sci. 19105,* on a decaying log at the elevation of 350 m.

Previously collected in Madagascar.

Polystictus caperatus (Berk.) comb. nov.

Polyporus caperatus Berk. Ann. Mag. Nat. Hist. 3: 391. 1839.

Trametes dibapha Berk. Vidensk. Meddel. 32. 1879.

Coriolopsis caperata Murr. N. Am. Flora **9**: 77. 1908.

MINDANAO: District of Davao, Mount Apo, April, 1904, *Copeland 1178*.

Of very general tropical distribution. Reported from the West Indies, Central America, South America and tropical Asia and Africa.

Polystictus Elmerianus (Murr.) comb. nov.

Inonotus Elmerianus Murr. Bull. Torrey Club **34**: 471. 1907.

Polyporus Elmerianus Sacc. & Trott.; Saccardo, Syll. Fung. **21**: 274. 1912.

LUZON: Province of Bataan, Mount Mariveles, November, 1904, *Elmer 6942*, on dead and decaying logs.

Thus far reported only from the Philippines.

POLYSTICTUS FLABELLIFORMIS (Klotz.) Cooke, Grevillea **14**: 78. 1886.

Polyporus flabelliformis Klotz. Linnaea **8**: 483. 1833.

LUZON: Province of Laguna, Mount Maquiling, February, 1912, *P. W. Graff, Bur. Sci. 15933*, on fallen and decaying timber.

This is the second collection reported from the Philippines. The first was made by Warburg, on the island of Mindanao, in 1888. This species has also been collected in Ceylon and the East Indies.

Polystictus nigromarginatus (Schwein.) comb. nov.

Boletus hirsutus Wulf.; Jacquin, Collect. **2**: 149. 1788. Not Scop.

Boletus nigromarginatus Schwein. Syn. Fung. Carol. 72. 1818.

Polyporus hirsutus Fr. Syst. Myc. **1**: 367. 1821.

Coriolus nigromarginatus Murr. Bull. Torrey Club **32**: 649. 1906.

LUZON: Province of Rizal, Antipolo, *H. M. Curran, For. Bur. 7042*. Mindanao, District of Davao, Lake Lanao, Camp Keithley, June–July, 1907, *Mary S. Clemens*.

Wulfen's name being preoccupied by that of Scopoli, Schweinitz's name must be used for this species.

A species of very general distribution.

POLYSTICTUS OCCIDENTALIS (Klotz.) Fr. Nov. Symb. Myc. 90. 1851.

Polyporus occidentalis Klotz. Linnaea **8**: 486. 1833.
Trametes lanata Fr. Epicr. Myc. 490. 1838.
Trametes occidentalis Fr. Epicr. Myc. 491. 1838.
Trametes Wahlbergii Fr. Fungi Natal. 11. 1848.
Trametes scalaris Fr. Fungi Natal. 12. 1848.
Polyporus scorteus Fr. Nov. Symb. Myc. 89. 1851.
Trametes devexa Berk. Jour. Linn. Soc. Bot. **13**: 165. 1873.
Polyporus illotus Kalchbr. Grevillea **10**: 102. 1882.
Coriolopsis occidentalis Murr. Bull. Torrey Club **32**: 358. 1905.
LUZON: vicinity of Manila, August, 1912, *Sanchez 28*.

That this fungus is of very general tropical distribution is shown by the fact that it has been so variously described from such widely separated localities as Brazil, Guiana, St. Vincent, Natal, British India, Ceylon, and the East Indies.

Polystictus Ramosii (Murr.) comb. nov.

Hapalopilus Ramosii Murr. Bull. Torrey Club **35**: 400. 1908.
Polyporus Ramosii Sacc. & Trott.; Saccardo, Syll. Fung. **21**: 276. 1912.

LUZON: Province of Rizal, Bosoboso, July, 1908, *M. Ramos, Bur. Sci. 1198*, on dead *Calophyllum inophyllum*.

This fungus seems to have the characters of the genus *Polystictus* rather than of *Polyporus*.

Collected only in the Philippines.

POLYSTICTUS SUBCROCATUS (Murr.) Sacc. & Trott.; Saccardo, Syll. Fung. **21**: 224. 1912.

Coriolopsis subcrocata Murr. Bull. Torrey Club **35**: 394. 1908.

LUZON: Province of Rizal, July, 1907, *M. Ramos, Bur. Sci. 1859, 1864*.

As yet collected only in the Philippine Islands.

UNIVERSITY OF MONTANA,
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Boxwoods of commerce*

SAMUEL J. RECORD

(WITH ONE TEXT FIGURE)

TURKISH BOXWOOD

The original boxwood of commerce, commonly called Turkish boxwood, is supplied by *Buxus sempervirens* L. (Euphorbiaceae). This species (including closely related forms) has an extensive range throughout central and southern Europe, northern and western Asia, and northern Africa. It is a small tree at best and in parts of its range is reduced to a low shrub valued chiefly for ornamental purposes. The commercial range corresponds roughly to that of the Circassian or Persian walnut and the principal port of origin for wood shipments is Batum.

The wood has been used and prized for many centuries. Its very fine and uniform texture, its light and yellowish color, the ease with which it can be shaped or carved in spite of its horn-like density and irregular grain,† together with its freedom from warping and splitting when finished, have combined to give to this wood a unique place in a specialized field. For the more exacting uses, such as fine engravings, there is no satisfactory substitute.

The wood is not all of the same degree of excellence. The Abassian is considered the best on the American market, followed by the Anatolian and Persian in the order named. Most of the wood used by the Japanese is said to come from Siam and Burma. It is not so highly prized as the native wood (*Buxus japonica* Muell.), is considerably lighter in color, and the bitter taste is much less pronounced. The war stopped shipments of Turkish boxwood and they have not yet (1921) been resumed.

SOUTH AFRICAN BOXWOODS

The growing scarcity of Turkish boxwood stimulated search for substitutes, and in 1885 the East London or Cape boxwood

* Contribution from the Yale School of Forestry, No. 14.

† "There is no . . . box so knotty that dipped in oil cannot be carved." John Lyly: Euphues and his England, p. 368.

was introduced into the trade from eastern Cape Colony, South Africa. This is a true boxwood, *Buxus Macowani* Oliv., and is suitable for engraving, though less highly esteemed than the Turkish for this purpose. The preference for the latter is shown by the fact that block-makers are salvaging used blocks, cutting them into thin layers and gluing these to hard maple backs to get the proper height.

Another wood out of Cape Colony is the Kamassi or Knysna boxwood, also known as East London and Cape boxwood. This is produced by *Gonioma Kamassi* E. Mey. of the family Apocynaceae, which contains many fine-textured woods. The Dutch name is "kamassi" or "kamassihout." Although the wood has a fine and uniform texture it is not adapted for engraving and has found its principal use in the weaver's trade for shuttles and bobbins. It has practically disappeared from the New York market.

TROPICAL AMERICAN BOXWOODS

Much of the boxwood of commerce is now supplied by the forests of the American tropics under the general name of "West Indian boxwood." There has been much confusion regarding the identity of the species producing this material. In most works of reference it is erroneously referred to *Tecoma pentaphylla* Juss. (= *Tabebuia pentaphylla* Hemsl.) of the family Bignoniaceae. This mistake arose about 1884, apparently as the result of the incorrect labeling of a wood specimen in the museum at Kew, England. The wood actually produced by this tree has none of the properties of boxwood and is locally known as "roble" (oak), name giving some idea of its appearance.

In 1880, A. Ernst published a note in the Botanisches Centralblatt to the effect that the tree supplying the boxwood of Venezuela was *Aspidosperma Vargasii* DC. (Apocynaceae). He gave the local name as "amarilla yema de huevo," referring to the resemblance of the color of the wood to that of the yolk of an egg.

In 1914, Sprague and Boodle contributed a paper to the Kew Bulletin of Miscellaneous Information in which they established the identity of certain specimens of West Indian or Venezuelan boxwood as *Casearia praecox* Griseb. (Samydaceae or Flacourtiaceae). They expressed the opinion that the wood referred to

by Ernst as *Aspidosperma Vargasii* and by others as *Tabebuia pentaphylla* was in reality *Casearia praecox* or some closely related species of this genus.

"ZAPATERO" AND "AMARILLO" OF VENEZUELA

The present writer finds that instead of one there are at least three so-called West Indian boxwoods on the market. The principal one is, as Sprague and Boodle state, *Casearia praecox*. This is the "zapatero" of Venezuela. Whether or not Ernst was right in referring the particular specimen he described to *Aspidosperma Vargasii* (his description indicating *Casearia*), it seems definitely established that this species has produced considerable quantities of boxwood, though it is now almost if not entirely out of the American market. There is evidence available that there is at least one other species of *Aspidosperma* in Venezuela producing "amarillo," as the wood of that genus is locally known. There are still other species in Brazil which are in the boxwood class, particularly *A. eburneum* All., the "piquia marfim." *Esenbeckia Atata* Pittier (Rutaceae) has many properties in common with the zapatero and the amarillo but, so far as known to the writer, this wood is not on the market.

"BAITOA" OR SAN DOMINGAN BOXWOOD

The third West Indian boxwood is from Santo Domingo. This first came to the writer's attention in 1918 in the form of a battery commander's ruler. The wood proved to have the same structure as the "palo lanza" or "guayabi amarillo" of northern Argentina. Through the courtesy of the Director of the New York Botanical Garden the writer was able to establish the identity of these woods as *Phyllostylon brasiliensis* Capanema (= *Phyllostylon rhamnoides* Taubert = *Samaroceltis rhamnoides* Poisson) of the family Ulmaceae. This identification has since been confirmed by Mr. C. D. Mell, who at the writer's suggestion made some observations on the species while on a trip to Haiti. This tree, of which there is supposed to be only a single species, is known to occur in Argentina, Brazil, eastern Cuba, Santo Domingo and Haiti. See FIG. 1.

The wood reaches the New York market in considerable quan-

tity from Santo Domingo, where it is known as "baitoa" and sometimes as "bois blanc." There is not much information available regarding its distribution, but it is known to occur in the val-

FIG. 1. PHYLLOSTYLON BRASILIENSIS Capanema. *A*. Twig and leaves from Haiti. *B*. Smaller leaf from Oriente, Cuba. *C*. Fruit from Cuba. All natural size.

leys of the Yaque del Norte and Yaque del Sur, where it is a common tree in small pure stands or in mixture with other trees. It reaches there a diameter of 20 inches and is from 50 to 70 feet

high. Mr. Mell found it quite abundant in parts of Haiti, where it reaches the same dimensions and has the same habits as above mentioned. A common characteristic noted is the fluted trunk and the presence of abundant epiphytes on the branches. The wood is little used locally. The following is from his notes:

The "bois blanc" is one of the most common trees in the dry calcareous regions of the west and north of the island and is said to be most plentiful in the flat and arid regions south of Gonaives in Haiti and on the low dry foothills and lower slopes of the mountains around Puerto Plata in Santo Domingo. Only rarely is it found on the upper slopes and tops of the mountains. It appears to prefer the flat lands that are dry and rocky where it is often found growing thickly in pure forest.

The crowns of the trees are so open that in the pure stands the sunlight reaches the ground and the trees are accordingly rather short boled. In mixture with other trees casting a denser shade the height is greater and occasional specimens may be seen that are 30 feet to the first large limb and as much as 18 inches in diameter breast high. Usually the trunks are irregular and few of them are suitable for lumber.

The leaves are small and not very numerous. Every tree, regardless of its site or associates, seems to be full of epiphytic plants which appear to interfere with its development.

The wood is not esteemed very highly by the natives except for making fence posts and square timbers for buildings of all kinds. Only the smaller sizes are used and the large trees do not seem to be cut for any purpose.

The San Domingan boxwood is inferior to both of the woods from Venezuela. It is not suitable for engraving but makes satisfactory shuttles (its principal use at present) and a fair grade of rulers. It varies in color from very light to canary yellow or light brown. An interesting feature of its structure is the presence of calcium carbonate in a large proportion of the vessels, readily visible with the lens and sometimes without it. The effervescence resulting from the application of a drop of hydrochloric acid to the end of a specimen affords a very simple and reliable means of separating this wood from the others of the group.

SOME OTHER WOODS CALLED BOXWOOD

The flowering dogwood, *Cornus florida* L. (Cornaceae), is sometimes called American boxwood, presumably because of its use in the place of the true boxwood for shuttles. Since the color is reddish or greenish instead of yellowish and the rays are pronounced there is no occasion to confuse it with the other woods of the group. *Schaefferia frutescens* Jacq. (Celastraceae), a small tree of southern Florida and the West Indies, is sometimes known as boxwood but it does not enter the market.

In Australia the name box is applied to various species of *Eucalyptus* and to *Tristania conferta* R. Br. (Myrtaceae). The structure of these woods is distinct from the boxwoods of commerce. The writer is as yet unable either to verify or disprove the statement often met with that the boxwood of the Bahamas is *Vitex umbrosa* Sw. (Verbenaceae). Apparently there is no such wood on the market.

USES OF BOXWOOD

The principal uses of boxwood are for engraving, manufacture of mathematical instruments, shuttles, turnery, musical instruments, and in the form of veneer for inlay and marquetry. The Japanese use it for making combs. Jewelers use wheels of it for burnishing and the sawdust for polishing. There was formerly considerable demand for it by makers of roller skates. The manufacture of boxwood spools for wires in telephone boxes made use of considerable small Turkish boxwood sticks but composition spools have replaced the wooden ones.

The use of wood engravings persists in spite of the advance of other methods. The number of engravers in the United States is said to be about 200 of whom 150 are located in Chicago. The blocks are cut edge-grain and are seven eighths inch high. The best blocks measure 2 x 2 inches free of the pith and can only be procured from logs measuring not less than $4\frac{1}{2}$ inches in diameter. Cuttings from these blocks are built up into blocks of any desired size. Small defects may be bored out and plugged.

APPEARANCE OF BOXWOOD LOGS

The boxwoods are imported in the form of logs or small sticks. The Turkish, East London, and Knysna varieties look like cordwood in the round and are usually very knotty and crooked. The material is usually sorted as to sizes in the yards of the dealers, and Turkish boxwood sticks as small as one inch in diameter are merchantable.

The logs of Venezuelan boxwoods are 8 to 12 feet long, mostly straight, smooth and round, and vary in diameter from 6 to 20 inches, mostly 6 to 10 inches. The larger logs are commonly sawed in half lengthwise and stored in dry sheds to prevent splitting.

The "baitoa" logs from Santo Domingo are from 8 to 20 inches in diameter and 10 or 12 feet in length. They are irregular, and may be more or less fluted. The more prominent irregularities are usually hewn off. A pile of this material resembles a lot of sugar maple logs.

Boxwood logs are measured at the small end, usually outside the bark. Owing to the tendency of the West Indian boxwoods to discolor in a humid atmosphere it is necessary to store the logs in a dry shed.

BARK CHARACTERS OF THE BOXWOODS

The bark characters of the different woods are distinctive. In *Buxus sempervirens* the bark is extremely thin, usually not more than $\frac{1}{16}$ inch, is gray in color, and clings tightly to the wood. In *B. Macowani* it is rather thick, $\frac{1}{8}$ to $\frac{1}{4}$ inch, composed of an inner dark layer and an outer lighter corky layer in narrow longitudinal ridges suggesting white ash.

In *Gonioma Kamassi* the bark is about $\frac{1}{4}$ inch thick, shows two distinct layers the outer of which is yellow on cross-section but grayish on the surface, irregularly fissured and somewhat flaky.

Aspidosperma Vargasii has a bark about $\frac{1}{4}$ inch thick, with a thick deep-yellow inner layer and a thin outer layer composed of laminations alternating light and dark. There are no concentric lines in the inner bark and the phloem rays are scarcely distinct with a lens. The outer surface shows large splotches of gray, has short horizontal fissures and very irregular shallow vertical ones.

In *Casearia praecox* the bark is from $\frac{1}{8}$ to $\frac{3}{16}$ inch thick, indistinctly two-layered, the outer being thin, smoothish, brown or mottled, and with fine vertical wrinkles in the smaller sizes and flaking off irregularly to a light gray without furrows in the larger. Inner bark has distinct wedge-shaped rays and concentric zones, and, when fresh, exudes a resin which stains the edge of the wood.

In *Phyllostylon brasiliensis* the bark is from $\frac{3}{16}$ to $\frac{7}{16}$ inch thick, without distinct layers. The outer surface in young specimens is greenish-gray, somewhat wrinkled, and with prominent lenticels which may be elongated horizontally; in large logs the color is ashy gray, smoothish-granular or with irregular corky ridges. The inner bark shows numerous fine wavy rays and very fine

concentric lines, and with irregular wedge-shaped patches here and there extending from the outer surface to varying depths. The inner surface shows a storied structure more or less distinctly under the lens. The number of ripple marks per inch of length is about 140.*

Descriptive key to the boxwoods of commerce

(Microscopic features)

A. Vessel perforations scalariform (mostly 5–10 bars). Wood parenchyma diffuse and in short tangential rows; no concentric lines. Rays heterogeneous; large cells thick-walled; pits into vessels small, half-bordered. Fibers without gelatinous layer; often arranged in fairly definite radial rows, and somewhat flattened at termination of growth rings. Pores open, well distributed, single, rounded, mostly under 0.03 mm. (tang. diam.). Vessel pits small, border circular, aperture very small, dot-like. Growth rings defined by narrow pore-less zones.

a. Wood fibers with inconspicuous, indistinctly bordered pits. Rays 1–3, mostly 1 or 2, cells wide; 1–15, in some specimens 1–30, cells high; max. 0.02 mm. × 0.25 – 0.40 mm. TURKISH BOXWOOD; *Buxus sempervirens* L.

b. Wood fibers with distinctly bordered pits; sometimes very prominent. Rays 1–3, mostly 2, cells wide; 1–20, mostly 8–10, cells high; max. 0.02 mm. × 0.17 mm. EAST LONDON or CAPE BOXWOOD; *Buxus Macowani* Oliv.

B. Vessel perforations simple.

a. Wood parenchyma absent or very rare. Rays narrow, 1–3 cells wide; crowded; few to 75 cells high; max. 0.03 mm. × 1.5 mm.; heterogeneous; crystals very common; pits into rays very small, half-bordered, with lattice-like appearance. Fibers with gelatinous layer in part; often in definite radial rows due to crowding of rays; sometimes falsely septate with resin-plates; pits simple but often conspicuous. Middle lamella often very thick at corners and of a deep yellow color. Pores open, arranged mostly in radial rows of 2–8, usually 2–4; commonly not flattened; mostly under 0.04 mm. (tang. diam.). Vessel pits very small with slit-like apertures which may extend beyond borders and appear to coalesce into spirals. Growth rings present but more distinct under simple lens than under compound microscope. ZAPATERO, or (COMMON) WEST INDIAN or VENEZUELAN BOXWOOD; *Casearia præcox* Griseb.

b. Wood parenchyma present and distinct. Rays rarely 40 cells high.

a[1]. Rays homogeneous or nearly so; mostly uniseriate; 1–20 cells high; max. 0.01–0.02 mm. × 0.30 mm.; pits into vessels half bordered. Parenchyma diffuse; rarely in tangential lines except at margins of growth rings. Fibers without gelatinous layer; some tendency to radial arrangement; pits distinctly bordered. Pores single; comparatively large; larger pores 0.06–0.07 mm. (tang. diam.); open. Vessel pits comparatively large with apertures extending beyond borders. Growth rings defined by narrow pore-less zones. AMARILLO, or VENEZUELAN BOXWOOD; *Aspidosperma Vargasii* DC.

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* The only other member of this family (Ulmaceæ) in which ripple marks are known to occur is *Holoptelea integrifolia* (Roxb.) Planch.

b^1. Rays heterogeneous; 1–4, mostly 2–3, cells wide; 1–30 or 1–40 cells high. Parenchyma in tangential lines.

a^2. Wood fibers with thick gelatinous layer and yellowish granular contents; no radial arrangement; pits small, indistinct, simple. Pores in part filled with calcium carbonate; sometimes with tyloses; arranged singly or in radially compressed rows of 2–5; larger pores 0.04–0.05 mm. (tang. diam.). Vessel pits comparatively large with elongated apertures; segments in horizontal seriation (tangential section) with parenchyma strands (mostly 2 cells per strand), and with low rays. High rays usually constricted slightly at junction of tiers (2 to 5 per ray); width 0.025–0.04 mm., heights in multiples of about 0.17 or 0.18 mm. up to five; pits into vessels large, simple to distinctly bordered; crystals common. Growth rings limited by line of wood parenchyma: slight difference in density. BAITOA, or SAN DOMINGAN BOXWOOD; ***Phyllostylon brasiliensis*** Cap.

b^2. Wood fibers without gelatinous layer and without contents; tendency to radial arrangement; pits distinctly bordered. Pores open or with yellowish gum contents; arranged singly or occasionally in pairs; larger pores about 0.04 mm. (tang. diam.). Vessel pits very small; segments not in horizontal seriation. Rays 1–30 cells high; max. 0.03–0.04 mm. × 0.6 mm.; pits into vessels small, half bordered, lattice-like appearance; many cells with yellow contents; no crystals observed. Growth rings due to narrow pore-less zones. KNYSNA or KAMASSI BOXWOOD; ***Gonioma Kamassi*** E. Mey.

CHECK LIST OF THE COMMON NAMES OF THE BOXWOODS

Buxus sempervirens: Box, boxwood, Turkish boxwood (general); Abassian, Anatolian, Circassian, Corsican, English, Parthenian, Persian, and Turkish boxwoods (trade); buis, buis commun, buis beni (French); gemeine Buchsbaum, Buchsbaumholz, Buchsholz (German); buxo, madeira de buxo (Portuguese); boj, madera de boj (Spanish); bossó, bosso comun, bossolo (Italian); boksboom, boksboomhout, busboom (Dutch); buxbom, buxbomsträ (Swedish); boksboom buksbom (Danish); tsuge, hon-tsuge, asama-tsuge, benten-tsuge, kara-tsuge, detchiki (Japan); wong-yong, huan-yang (China); fang-guyan-gmok (Korea); shanda laghúne (Afghanistan); chikri (Kashmir); papri, papar, paprang, shamshad, shumaj (Punjab); shibsashin (Byans); box (Anglo Saxon); buxus (Latin); teasshur (Hebrew).

Buxus Macowani: Cape boxwood, East London boxwood, African boxwood (Trade).

Gonioma Kamassi: Kamassi boxwood, Knysna boxwood, East London boxwood, Cape boxwood (trade); kamassi, kamassihout (Dutch).

Casearia praecox: West Indian boxwood, Venezuelan boxwood, Maracaibo boxwood (trade); India boxwood (European trade); zapatero, sapatero, naranjillo (?), limoncillo (?) (Venezuelan); raspalenga (?), zapatero (Cuba); buis d'Amérique (French).

Aspidosperma Vargasii: West Indian boxwood, Venezuelan boxwood (trade); amarillo, amarilla yema de heuvo (Venezuelan).

Phyllostylon brasiliensis: San Domingan boxwood (trade); baitoa, bois blanc (Santo Domingo); bois blanc (Haiti); pao branco (Brazil); ibirá-katú, ibirá-catú, palo lanza, palo lanza negro, yaó-si-guazú, tala grande, palo amarillo (Argentina).

INDEX TO AMERICAN BOTANICAL LITERATURE

1911–1921

The aim of this Index is to include all current botanical literature written by Americans, published in America, or based upon American material; the word America being used in the broadest sense.

Reviews, and papers that relate exclusively to forestry, agriculture, horticulture, manufactured products of vegetable origin, or laboratory methods are not included, and no attempt is made to index the literature of bacteriology. An occasional exception is made in favor of some paper appearing in an American periodical which is devoted wholly to botany. Reprints are not mentioned unless they differ from the original in some important particular. If users of the Index will call the attention of the editor to errors or omissions, their kindness will be appreciated.

This Index is reprinted monthly on cards, and furnished in this form to subscribers at the rate of three cents for each card. Selections of cards are not permitted; each subscriber must take all cards published during the term of his subscription. Correspondence relating to the card issue should be addressed to the Treasurer of the Torrey Botanical Club.

[Abbott, W. L., & Leonard, E. C.] Biological exploration in Haiti [1920]. Smithson. Misc. Coll. **72**[6]: 43–47. *f. 56–59.* 1921.

Adams, J. F. Observations on wheat scab in Pennsylvania and its pathological histology. Phytopathology **11**: 115–124. *pl. 2, 3 + f. 1.* Mr 1921.

Almquist, S. Rosae musei regni suecici in methodum naturalem redactae. Arkiv Bot. **16**[9]: 1–51. *f. 1–6 + tab. 1–8.* 16 Je 1920.

Appleman, C. O. Evaluation of climatic temperature efficiency for the ripening processes in sweet corn. Jour. Agr. Research **20**: 795–805. *f. 1.* 1 Mr 1921.

Babcock, E. B. Bud selection and the frequency of mutations. Bull. Dept. Agr. California **10**: 137–140. Ap 1921.

Baez, J. R. Somera relacion de la vegetacion suburbana de Parana [Argentina]. Anal. Assoc. Estud. Mus. Popul. Paraná **1920**: 35–41. *f. 1–4.* 1920.

Baker, F. C. The life of the Pleistocene or Glacial Period. Univ. Illinois Bull. 17, n. 41: 1–476. *pl. 1–57 + f. 1–3.* 7 Je 1920.

Baker, F. S. Two races of aspen. Jour. For. **19**: 412, 413. Ap 1921.
Populus tremuloides in Utah.

Baker, F. S. Black walnut, its growth and management. U. S. Dept. Agr. Bull. 993: 1–43. *pl. 1–7 + f. 1–4.* 8 Mr 1921.

Barker, E. E. El mejoramiento de nuestras siembras por la seleccion. Puerto Rico Dept. Agric. y Trab. Circ. 30: 3–23. Jl 1920.

Barrett, J. T. Apricot fruit spots. Univ. California Jour. Agr. **3**: 346–349. My 1916. [Illust.]

Barss, H. P. Apple tree anthracnose. Rep. Board Hort. Oregon **16**: 127–130. 1921. [Illust.]

Benoist, R. Contribution a l'étude de la flore de la Guyane française. Bull. Mus. Hist. Natur. **1920**: 351–357. 1920.
Includes 2 new species in *Casearia.*

Benoist, R. Plantas recoltées par M. Wachenheim en Guyane française. Bull. Mus. Hist. Natur. **1920**: 555–560. 1920.
Includes *Duroia plicata* sp. nov.

Berbert-Hammond, B. The trailing arbutus. Fl. Grow. **8**: 63. 1 Ap 1921.

Blake, S. F. New trees and shrubs from Yucatan. Proc. Biol. Soc. Washington **34**: 43–46. 31 Mr 1921.
New species in *Acacia* (2), *Diospyros* (1), *Citharexylum* (1), *Randia* (1) and *Notoptera* (1).

Blakeslee, A. F. A graft-infectious disease of *Datura* resembling a vegetative mutation. Jour. Genet. **11**: 17–36. *pl. 2–6.* 21 Ap 1921.

Bliss, M. C. The vessel in seed plants. Bot. Gaz. **71**: 314–326. *pl. 16–20.* 15 Ap 1921.

Børgesen, F. The marine algae of the Danish West Indies. III. Dansk Bot. Ark. **3**: 369–504. *f. 361–435.* 1920.
Includes *Coelothrix* and *Hypneocolax* gen. nov., and new species in *Gracilaria* (1), *Rhodymenia* (1), *Endoderma* (2), *Ascocyclus* (1), *Myriotrichia* (1), *Acrochaetium* (1).

Bowman, H. H. M. Deterioration in some horticultural varieties through deficient artificial selection. Jour. Hered. **11**: 380–383. 19 Ap 1921.
Studied *Callistephus, Zinnia, Tagetes, Matthiola* and *Centaurea.*

Brannon, J. M. A simple method for growing plants. Am. Jour. Bot. **8**: 176–178. *f. 1.* 3 Ap 1921.

Britton, N. L. The leafy spurge becoming a pest. Jour. New York Bot. Gard. **22**: 73–75. *f. 1.* Ap 1921.

Brotherus, V. F. Contribution à la flore bryologique de l'Ecuador. Rev. Bryol. **47**: 1–16, 35–46. 1920.
Includes 36 new species.

Bruner, S. C. Lista preliminar de las enfermedades de las plantas de importancia economica para Cuba. In Calvino, N., Informe de las años 1918–1919 y 1919–1920 de la Estacion Experimental Agronomica, 723–763. 1920. [Illust.]

Bryan, M. K. A bacterial budrot of cannas. Jour. Agr. Research **21**: 143–152. *pl. 31–38.* 2 My 1921.
Caused by *Bacterium Cannae* sp. nov.

Buckner, G. D. Comparative utilization of the mineral constituents in the cotyledons of bean seedlings grown in soil and in distilled water. Jour. Agr. Research **20**: 875–880. 1 Mr 1921.

Burgeff, H. Sexualität und Parasitismus bei Mucorineen. Ber. Deutsch. Bot. Ges. **38**: 318–327. *f. 1.* 12 Ja 1921.

Burger, O. F. Variations in *Colletotrichum gloeosporioides*. Jour. Agr. Research **20**: 723–736. *pl. 86 + f. 1, 2.* 1 F 1921.

Burger, O. F., & Swain, A. F. Observations on a fungus enemy of the walnut aphis in southern California. Jour. Econ. Entom. **11**: 278–288. *pl. 9.* 1918.

Burkholder, W. H. The bacterial blight of the bean: a systematic disease. Phytopathology **11**: 61–69. F 1921.

Burnham, S. H., & Latham, R. A. The flora of the town of Southold, Long Island, and Gardiner's Island. Torreya **21**: 1–11, 28–33. 1921.
Includes a new variety of *Nabalus trifoliolatus*.

Bush, B. F. Some species of *Podostemum*. Am. Mid. Nat. **7**: 29–41. Mr 1921.

Calvino, M. Informe de los años 1918–1919 y 1919–1920 de la Estacion Experimental Agronomica (Santiago de las Vegas, Cuba). Pp. 1–786. Habana, 1920. [Illust.]
Contains much information concerning economic plants.

Campbell, D. H. The Eusporangiatae. The comparative morphology of the Ophioglossaceae and Marattiaceae. Carnegie Instit. Washington Publ. 140: 1–229. *pl. 1–13 + f. 1–192.* 29 Au 1911.

Cannon, W. A. Botanical features of the Algerian Sahara. Carnegie Instit. Washington Publ. 178: 1–81. *pl. 1–36.* 6 Au 1913.

Cannon, W. A. The root habits of desert plants. Carnegie Instit. Washington Publ. 131: 1–96. *pl. 1–23 + f. 1–17.* 28 Mr 1911.

Cannon, W. A. The topography of the chlorophyll apparatus in desert plants. Carnegie Instit. Washington Publ. 98: 1–42. *pl. 1–5 + f. 1–15.* 1908.

Chardon Palacios, C. E. Un nuevo "smut" de Puerto Rico. Revista Agric. Puerto Rico **64**: 21–23. 30 Ap 1921. [Illust.]
Thecaphora pustulata Clinton, sp. nov.

Cobb, F. A case of Mendelian inheritance complicated by heterogametism and mutation in *Oenothera pratincola*. Genetics **6**: 1–42. Ja 1921.

Collins, F. S. Les algues marines de l'île de Vancouver. Canad. Geol. Surv., Bull. Mus. Commem. Victoria **1**: 117–158. 1913.
A French transcript of a paper published in Bull. Victoria Mem. Mus. **1**: 99–137. 23 O 1913.

Collins, G. N., & Kempton, J. H. Heritable characters of maize. I. Lineate leaves. Jour. Heredity **11**: 3–6. 10 F 1920. [Illust.]

Deam, C. C. Trees of Indiana (First revised edition). Publ. Dept. Conserv. Indiana **13**: 1–317. *pl. 1–137*. Ap 1921.

Dickson, J. G. The relation of certain nutritive elements to the composition of the oat plant. Am. Jour. Bot. **8**: 256–272. *f. 1, 2*. 24 My 1921.

Dode, L. A. Notes dendrologiques. Bull. Soc. Dendr. France **38**: 19–35. 15 F 1921.
Notes on various species of *Populus*, including *P. manitobensis* sp. nov. from Canada.

Douglass, A. E. Climatic cycles and tree growth. A study of the annual rings of trees in relation to climate and solar activity. Carnegie Instit. Washington Publ. 289: 1–127. *pl. 1–2* + *f. 1–40*. 1919.

Douglass, A. E. A method of estimating rainfall by the growth of trees. In Huntington, E., The climatic factor as illustrated in arid America. Carnegie Instit. Washington Publ. 192: 101–121. *pl. 4* + *f. 9–25*. 15 My 1914.

Dunn, G. A. A comparative study of the two races of *Rhizopus nigricans*. Physiol. Researches **2**: 301–339. *f. 1*. Ap 1921.

Dunn, G. A. Note on the histology of grain roots. Am. Jour. Bot. **8**: 207–211. *f. 1–4*. 30 Ap 1921.

Duursma, G. D. *Cereus flagelliformis*. Succulenta **3**: 15, 16. 9 Mr 1921.

Earle, F. S. The year's experience with sugar-cane mosaic or yellow stripe disease. Jour. Dept. Agr. Porto Rico **3**[4]: 3–33. O 1919.

Eaton, E. C. A large apple tree. Tree Talk **4**: 25. 1916.

Eddelbüttel, H. Fossile Pflanzen als Klimazeugen. Verh. Naturw. Vereins Hamburg III. **22**: LI–LIII. 1915

Elliott, J. A. A mosaic of sweet and red clovers. Phytopathology **11**: 146–148. *f. 1.* Mr 1921.

Emerson, R. A. Heritable characters of maize. II. Pistillate flowered maize plants. Jour. Heredity **11**: 65–76. *f. 9–16.* 26 Mr 1920.

Enlows, E. M. A., & Rand, F. V. A lotus leaf-spot caused by *Alternaria Nelumbii* sp. nov. Phytopathology **11**: 135–140. *pl. 4 + f. 1.* Mr 1921.

Etter, B. E. Field-cultures of wood-rotting fungi in agars. Phytopathology **11**: 151–154. Mr 1921.

Evans, A. W. *Taxilejeunea pterogonia* and certain allied species. Bull. Torrey Club **48**: 107–135. *pl. 2 + f. 1–22.* 4 Ap 1921.
Includes 2 new species from Jamaica.

Eyster, W. H. Heritable characters of maize. VI. Zigzag culms. Jour. Heredity **11**: 349–357. *f. 8–16.* 19 Ap 1921.

Farwell, O. A. Corrections in nomenclature. Rhodora **23**: 86. 87. 28 Ap 1921.
New combinations in *Carex.*

Farwell, O. A. *Mondo*, Adans. Am. Midl. Nat. **7**: 41–43. Mr 1921.

Fassett, N. C. An estuarian variety of *Scirpus Smithii.* Rhodora **23**: 41–43. 5 Ap 1921.

Fassett, N. C. *Sium suave:* a new and an old form. Rhodora **23**: 111–113. *f. 1, 2.* 19 My 1921.
Includes 2 new names.

Fawcett, H. S. Citrus diseases of Florida and Cuba compared with those of California. California Agr. Exp. Sta. Bull. 262: 153–210. *f. 1–24.* 1915.

Fawcett, H. S. Fighting a fungus, *Pythiacystis citrophthora*, in the citrus orchards. Univ. California Jour. Agr. **3**: 339–343, 356. *f. 1–3.* My 1916.

Fernald, M. L. *Scutellaria epilobiifolia.* Rhodora **23**: 85, 86. 28 Ap 1921.

Fernald, M. L., & St. John, H. The American variations of *Silene acaulis.* Rhodora **23**: 119, 120. 19 My 1921.

Fernald, M. L., & Weatherby, C. A. *Equisetum fluviatile* or *E. limosum?* Rhodora **23**: 43–47. 5 Ap 1921.

Fink, B. Notes on the powdery mildews of Ohio. Ohio Jour. Sci. **21**: 211–216. Ap 1921.

Florin, R. Über Cuticularstrukturen der Blätter bei einigen rezenten und fossilen Coniferen. Arkiv Bot. **16**[6]: 1–32. *pl. 1 + f. 1–9.* 2 Mr 1920.

Forsaith, C. C. The morphology of wood in relation to brashness. Jour. For. **19**: 237–249. Mr 1921. [Illust.]

Fred, E. B., Peterson, W. H., & Anderson, J. A. The relation of lactic acid bacteria to corn silage. Jour. Biol. Chem. **46**: 319–327. Ap 1921.

Fries, R. E. Revision der von Glaziou in Brasilien gesammelten Amarantaceen. Arkiv Bot. **16**[12]: 1–21. *pl. 1 + f. 1–5.* 21 Je 1920.

Includes *Froelichiella* and *Pseudogomphrena*, gen. nov., and new species in *Alternanthera* (2), *Gomphrena* (1), *Pseudogomphrena* (1).

Fries, R. E. Zur Kenntnis der süd- und zentralamerikanischen Amarantaceen-flora. Arkiv Bot. **16**[13]: 1–43. *pl. 1–4 + f. 1–11.* 18 Je 1920.

Includes new species in *Pfaffia* (3), *Alternanthera* (3), *Gomphrena* (7), *Iresine* (1).

Funck, N. Venezolanische Reiseerinnerungen. Bull. Mens. Soc. Natur. Luxembourg. **30**: 120–122; 139–140. 1920.

Gardner, M. W., & Kendrick, J. B. Bacterial spot of tomato. Jour. Agr. Research **21**: 123–156. *pl. 24–28.* 15 Ap 1921.

Gardner, M. W., & Kendrick, J. B. Tomato bacterial spot and seed disinfection. Bull. Purdue Univ. Agr. Exp. Sta. 251: 1–15. *f. 1–10.* F 1921.

Gardner, W. A. Effect of light on germination of light-sensitive seeds. Bot. Gaz. **71**: 249–288. 15 Ap 1921.

Gilbert, W. W. Cotton diseases and their control. U. S. Dept. Agr. Bull. 1187: 3–32. *f. 1–18.* Mr 1921.

Gilg, E. Eine neue prachtvoll blühende *Gentiana*-Art (*Gentiana regina*) aus Peru. Notizbl. Bot. Gart. und Mus. Berlin-Dahlem **7**: 509–511. 1 Mr 1921.

Godfrey, G. H., & Harvey, R. B. Motion pictures of zoospore production in *Phytophthora*. Phytopathology **11**: 145, 146. *pl. 6.* Mr 1921.

Haenseler, C. M. The effect of salt proportions and concentration on the growth of *Aspergillus niger*. Am. Jour. Bot. **8**: 147–163. *f. 1–6,* 3 Ap 1921.

Hansen, A. A. Lawn pennywort: a new weed. U. S. Dept. Agr. Circ. 165: 1–6. *f. 1–3.* Ap 1921.

Hanson, H. C. Distribution of the Malvaceae in southern and western Texas. Am. Jour. Bot. **8**: 192–206. *f. 1.* 30 Ap 1921.

Harlan, H. V., & Anthony, S. Effect of time of irrigation on kernel development of barley. Jour. Agr. Research **21**: 29–45. *f. 1–20.* 1 Ap 1921.

Harms, H. Eine neue Cucurbitacee aus Peru. Notizbl. Bot. Gart. und Mus. Berlin-Dahlem **7**: 502. 1 Mr 1921.
Gurania Weberbaueri sp. nov.

Harms, H. Eine neue Gattung des Leguminosae-Caesalpinioideae aus Argentina. Notizbl. Bot. Gart. und Mus. Berlin-Dahlem **7**: 500, 501. 1 Mr 1921.
Stenodrepanum gen. nov.

Harms, H. Einige neue *Phaseolus*-Arten. Notizbl. Bot. Gart. und Mus. Berlin-Dahlem **7**: 503–508. 1 Mr 1921.
New species from Peru (4), Brazil (2), and Mexico (2).

Harper, R. M. Geography of central Florida. Ann. Rep. Florida Geol. Surv. **13**: 71–307. *f. 1–43*. Ap 1921.

Harris, J. A., & Sinnott, E. W. The vascular anatomy of normal and variant seedlings of *Phaseolus vulgaris*. Proc. Nat. Acad. Sci. **7**: 35–41. *Diagr. 1–4*. 15 Ja 1921.

Harshberger, J. W. The artistic anatomy of trees. Public Lect. Univ. Pennsylvania Faculty **7**: 419–441. 1920.

Harshberger, J. W. Slope exposure and the distribution of plants in eastern Pennsylvania. Bull. Geogr. Soc. Philadelphia **17**: 17–25. *f. 1–4*. Ap 1921.

Hastings, G. T. Succession of algae in the Grassy Sprain Reservoir [Yonkers, N. Y.]. Jour. New York Bot. Gard. **22**: 64–66. Mr 1921.

Hildebrandt, F. M. A physiological study of the climatic conditions of Maryland, as measured by plant growth. Physiol. Researches **2**: 341–405. *f. 1–8*. My 1921.

Hill, J. B. The rate of development of the cones of the Norway Spruce. Am. For. **27**: 256. Ap 1921.

[Hitchcock, A. S]. Botanical exploration in British Guiana [1919. 1920]. Smithson. Misc. Coll. **72**[6]: 54–58. *f. 67–71*. 1921.

Hitchcock, A. S. Report of the committee on nomenclature of the Botanical Society of America. Science II. **53**: 312–314. 1 Ap 1921.

Hitchcock, A. S. The type concept in systematic botany. Am. Jour. Bot. **8**: 251–255. 24 My 1921.

Hoehne, F. C. Monographia das Asclepiadaceas Brasileiras. *Oxypetalum*, R. Br. Comm. Linhas Teleg. Estrat. de Matto-Grosso ao Amazonas Publ. **38**[1]: 1–131. *pl. 1–59*. Au 1916; Addenda 1: 1–13. *pl. 60, 61*. Au 1916.
Includes 2 new species.

Hoehne, F. C. Monographia das Asclepiadaceas Brasileiras. *Calostigma*, Dcne. Comm. Linhas Telegr. Estrat. de Matto-Grosso ao Amazonas Publ. **38**[2]: 1–29. *pl. 1–12.* Au 1916.
Includes *C. Dusenii* sp. nov.

[**Hoehne, F. C**]. Seccao de botanica, in Mariano da Silva Rondon, C., Relatorio **3**: 38–41. 1915. Commissao de linhas telegraphicas estrategicas de Matto-Grosso ao Amazonas [Brazil].

House, H. D. The wild flower preservation idea is one of practical value. Torreya **21**: 17–21. Ap 1921.

Hungerford, C. W. A modification of the concentrated formaldehyde method of seed treatment. Phytopathology **11**: 149, 150. Mr 1921.

Hunnewell, F. W. An extended range for *Amelanchier amabilis*. Rhodora **23**: 71, 72. 1921.

Huntington, E. The climatic factor as illustrated in arid America. Carnegie Instit. Washington Publ. 192: 1–341. *pl. 1–12* + *f. 1–89*. 15 My 1914.

Hurd, A. M. Seed-coat injury and viability of seeds of wheat and barley as factors in susceptibility to molds and fungicides. Jour. Agr. Research **21**: 99–122. *pl. 13–23*. 15 Ap 1921.

Illick, J. S. Big trees in Pennsylvania. For. Leaves **18**: 24, 25. Ap 1921. [Illust.]

Inman, O. L. Comparative studies on respiration. XVII. Decreased respiration and recovery. Jour. Gen. Physiol. **3**: 663–666. *f. 1–3*. 20 My 1921.

Irmscher, E. Neue *Fissidens*-Arten aus Brasilien und Bolivien. Notizbl. Bot. Gart. und Mus. Berlin-Dahlem **7**: 533–537. 1 Mr 1921.
New species from Brazil (4), and Bolivia (2).

Jagger, I. C. Bacterial leafspot disease of celery. Jour. Agr. Research **21**: 185–188. *pl. 46, 47*. 2 My 1921.
Caused by *Pseudomonas Apii* sp. nov.

Johnson, D. S. William Harris. Bot. Gaz. **71**: 331–333. 15 Ap 1921.

Johnson, D. S., & York, H. H. The relation of plants to tide-levels. A study of factors affecting the distribution of marine plants. Carnegie Instit. Washington Publ. 206: 1–162. *pl. 1–24* + *f. 1–5*. 31 D 1915.

Jones, D. F. Heritable characters of maize. IV. A lethal factor—defective seeds. Jour. Heredity **11**: 161–167. *f. 9–15*. 6 Je 1920.

Kauffman, C. H. *Isoachyla*, a new genus of the Saprolegniaceae. Am. Jour. Bot. **8**: 231–237. *pl. 13, 14*. 24 My 1921.
Includes *I. toruloides* sp. nov., from Michigan.

Vol. 48 No. 12

BULLETIN

OF THE

TORREY BOTANICAL CLUB

DECEMBER, 1921

Phytogeographical notes on the Rocky Mountain region X. Grasslands and other open formations of the Montane Zone of the Southern Rockies

PER AXEL RYDBERG

In a previous article* I have discussed the wooded formations of the Montane Zone. In this article the remaining formations are taken up. In these, the plants of the plains and foothills make up a larger proportion of the vegetation than in the wooded formations. The river valleys, meadows, and hog backs have a flora much more like that of similar habitats in the foothill region and even on the plains. The transcontinental elements and those from the prairie region are much more numerous.

The formations have been arranged so that the hydrophytic are first taken up and then the mesophytic, the most xerophytic being left until the last. The species followed by a dagger, "†", are confined to the Southern Rockies.

A. AQUATIC FORMATIONS

Lakes are not very common in the Montane Zone of the Southern Rockies. In the higher parts they are mostly glacial, fed by the snow fields, and contain little vegetation. The brooks are swift and rarely form lakes or ponds in the higher regions. Most of the lakes are found in the lower river valleys and "Parks"

* Bull. Torrey Club 47: 441–454. 1920.

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of Colorado, and here we find most of the aquatic vegetation. The majority of the phaneorgamic plants are found also in the plains and prairie regions. To these belong a score of species of *Potamogeton* which here are omitted. Besides these the following species are found:

1. TRANSCONTINENTAL AND EASTERN

Sparganium angustifolium
Sparganium minimum
Triglochin palustris
Triglochin maritima
Alisma brevipes
Sagittaria latifolia
Phragmites Phragmites
Catabrosa aquatica
Panicularia grandis
Panicularia borealis
Panicularia septentrionalis
Eleocharis palustris
Scirpus validus
Lemna trisulca
Lemna gibba
Lemna minor
Crunocallis Chamissonis
Panicularia pauciflora
Agrostis depressa†
Cardamine cordifolia†
Persicaria coccinea
Batrachium trichophyllum
Batrachium flaccidum
Batrachium Drouetii
Ranunculus Purshii
Sisymbrium Nasturtium-aquaticum
Callitriche palustris
Callitriche autumnalis
Hippuris vulgaris
Sium cicutifolium
Menyanthes trifoliata
Veronica americana
Utricularia vulgaris
Utricularia minor

2. WESTERN

Nymphaea polysepala

3. ENDEMIC

Cardamine infausta†
Ranunculus intertextus†

B. SEDGE BOGS

The sedge bogs are found where the drainage is poor or in low places around lakes, ponds, and streams. In most cases the most numerous plants are species of *Carex*, but many grasses also are intermixed, and in some places they are predominant. Of these *Alopecurus aristulatus* and *Agrostis alba* are the most frequent and, in the lower part of the zone, species of *Calamagrostis*. The composition of the bog vegetation consists of the following plants:—

1. CONTINENTAL AND EASTERN

Deschampsia coespitosa
Phalaris arundinacea
Calamagrostis elongata
Calamagrostis canadensis
Calamagrostis hyperborea
Beckmannia erucaeformis
Panicularia nervata
Alopecurus aristulatus
Eriophorum angustifolium
Eriophorum gracile
Carex gynocrates
Carex diandra
Carex disperma
Carex canescens
Carex brunnescens
Carex leptalea
Carex aurea
Carex paupercula
Carex Buxbaumii
Carex aquatilis
Carex lanuginosa
Carex viridula
Carex rostrata
Carex retrorsa
Rumex occidentalis
Rumex mexicanus
Ranunculus sceleratus
Cardamine pennsylvanica
Parnassia parviflora
Argentina Anserina
Geum rivale
Viola palustris
Veronica Wormskjoldii
Elephantella groenlandica
Gnaphalium uliginosum
Senecio pauciflorus
Lycopodium annotinum
Equisetum arvense
Equisetum pratense
Equisetum variegatum

2. WESTERN

Poa interior
Agrostis humilis
Agrostis grandis
Agrostis asperifolia
Agrostis idahoensis
Muhlenbergia comata
Carex simulata
Carex athrostachya
Carex tenuirostris
Carex Raynoldsii
Carex Kelloggii
Juncus Mertensianus
Iris missouriensis
Limnorchis viridiflora
Limnorchis borealis
Rumex hymenosepalus
Alsine strictiflora
Alsine obtusa
Alsine calycantha
Ranunculus alismaefolius
Ranunculus Eschscholtzii
Argentina argentea
Vicia oregana
Vicia sparsiflora
Epilobium brevistylum
Epilobium occidentale
Dodecatheon pauciflorum
Castilleja exilis
Mimulus Lewisii
Galium subtriflorum
Aster occidentalis
Aster Burkei
Erigeron salsuginosus
Gnaphalium sulphurescens
Arnica longifolia

3. ENDEMIC

Alopecurus occidentalis
Graphephorum Sheariі†
Panicularia pauciflora
Agrostis Rossae
Agrostis melaleuca
Agrostis Bakeri†
Carex pseudoscirpoidea
Carex ebenea†
Juncus truncatus
Juncus Hallii
Sisyrinchium alpestre†
Rumex praecox†
Rumex subalpinus†
Rumex densiflorus†
Ranunculus inamoenus
Ranunculus acriforme
Ranunculus micropetalus†
Caltha rotundifolia†
Aconitum porrectum†
Aconitum columbianum
Clementsia rhodantha
Vicia dissitifolia†
Epilobium ovatifolium†
Epilobium americanum
Epilobium stramineum
Epilobium Drummondii
Epilobium wyomingense
Angelica pinnata
Primula incana
Dodecatheon philoscia†
Dodecatheon radicatum†
Anthopogon thermalis
Swertia scopulina
Myosotis alpestris
Castilleja sulphurea
Castilleja wyomingensis
Orthocarpus purpureo-albus
Erigeron minor
Erigeron lonchophyllus
Arnica rhizomata
Arnica foliosa
Senecio cymbalarioides
Senecio nephrophyllus
Senecio crassulus
Senecio semiamplexicaulis
Senecio rapifolius
Senecio dispar
Senecio perplexans

C. SPRINGY PLACES

The springs and the wet places in their vicinity usually have a flora of their own. This consists of hydrophytes, growing either in the water itself or on the muddy shores. As a rule the plants are small in size.

1. EASTERN AND TRANSCONTINENTAL

Eleocharis acicularis
Lemna trisulca
Lemna minor
Lemna gibba
Sisymbrium Nasturtium-aquaticum
Parnassia parviflora
Tillaeastrum aquaticum
Callitriche palustris
Callitriche autumnalis
Epilobium adenocaulon
Myosotis alpestris

2. WESTERN

Muhlenbergia filiformis
Juncus Mertensianus
Crunocallis Chamissonis
Parnassia fimbriata

Micranthes arguta
Androsace filiformis
Mimulus Langsdorfii

3. ENDEMIC

Agrostis depressa†
Cardamine cordifolia
Cardamine infausta†
Radicula alpina
Micranthes rhomboidea

Micranthes arnoglossa
Oxypolis Fendleri†
Primula incana
Pleurogyne fontana
Mimulus puberulus

D. SANDY RIVER BANKS

The flora of the sandy river banks and sand-flats along the water courses is very meager. Besides some of the species which are enumerated below, under the heading "Sand-draws," there are found the following which require more moisture:—

Eleocharis acicularis
Scirpus pauciflorus
Muhlenbergia Wolfii†
Sagina saginoides
Alsinopsis macrantha†
Myosurus aristulatus
Ranunculus reptans
Halerpestes Cymbalaria
Radicula alpina
*Subularia aquatica**

*Tillaeastrum aquaticum**
Gilia calcarea†
Androsace filiformis
Androsace diffusa†
Androsace subulifera†
Mimulus moschatus
Mimulus puberulus
*Limosella aquatica**
Erigeron minor

E. ALLUVIAL RIVER BANKS

The formations on the alluvial river banks and river flats are of three kinds. Along the smaller brooks, especially in the upper portion of the zone, they resemble much those of the Subalpine Zone, the most important plants being species of *Mertensia*, *Epilobium* and *Juncoides*. In the lower part of the zone *Urtica gracilis* and various composites constitute the greater part of the vegetation. At middle altitudes species of *Delphinium* and *Aconitum* often take their places. Very few of the plants are transcontinental or eastern.

* Growing mostly in shallow water with sandy bottom.

1. TRANSCONTINENTAL

Juncoides parviflorum
Juncoides intermedium
Juncoides spicatum
Urtica gracilis
Epilobium adenocaulon
Veronica Wormskjoldii
Artemisia biennis

2. WESTERN

Amaranthus Powellii
Delphinium multiflorum
Epilobium occidentale
Rudbeckia occidentalis
Senecio triangularis

3. ENDEMIC

Delphinium occidentale
Delphinium reticulatum
Delphinium robustum†
Delphinium elongatum†
Delphinium ramosum†
Delphinium cucullatum†
Aconitum insigne
Aconitum lutescens
Aconitum Bakeri†
Epilobium Palmeri†
Epilobium rubescens†
Epilobium stramineum†
Mertensia ciliata
Mertensia Leonardi†
Mertensia brevistyla†
Scrophularia occidentalis
Rudbeckia ampla
Rudbeckia montana†
Helianthella quinquenervis
Cirsium Parryi†
Cirsium scopulorum†
Cirsium Centaureae†
Cirsium Eatonii
Cirsium coloradense†
Cirsium oreophilum†
Cirsium foliosum
Cirsium griseum†

F. MEADOWS

By meadows I mean here the more moist meadows of the richer bottom lands. There are also grasslands which bear hay-making grasses in the dryer portions of the valleys, which I have included in the Dry Valley Formation. The grasses of the wet meadows consist mostly of species of the tribes Agrostideae and Festuceae. Those of the latter are mostly of the tribe Hordeae and are found on the plains also. The list of grasses is given in an earlier article* and is here omitted.

* Bull. Torrey Club **43**: 635–636. 1915.

1. EASTERN AND TRANSCONTINENTAL

Carex stenophylla
Carex lanuginosa
Carex interior
Juncus Vaseyi
Juncus bufonius
Polygonum ramosissimum
Capnodes aureum
Arabis ovata
Draba nemorosa
Vicia trifida
Viola nephrophylla
Viola septentrionalis
Viola pedatifida
Artemisia biennis

2. WESTERN

Juncus longistylis
Juncus confusus
Juncodes comosum
Anticlea elegans
Polygonum sawatchense
Polygonum Watsonii
Potentilla Bakeri
Potentilla Nuttallii
Potentilla diversifolia
Drymocallis glandulosa
Lupinus argenteus
Astragalus striatus
Astragalus goniatus
Viola venosa
Viola vallicola
Oenothera Hookeri
Lavauxia flava
Collomia linearis
Orthocarpus luteus
Antennaria corymbosa
Arnica Rydbergii
Arnica fulgens
Agoseris laciniata

3. ENDEMIC

Juncus Jonesii
Carex pseudoscirpoidea
Veratrum tenuipetalum†
Calochortus Gunnisoni
Calochortus Nuttallii
Calochortus acuminatus
Polygonum Engelmannii
Claytonia rosea
Thalictrum venulosum
Thalictrum megacarpum
Arabis rhodantha
Potentilla filipes
Potentilla juncunda
Potentilla pulcherrima
Potentilla plattensis
Potentilla propinqua
Potentilla Nelsoniana
Fragaria pauciflora
Drymocallis convallaria
Trifolium Rydbergii
Trifolium Kingii†
Astragalus sulphurescens
Aragallus albiflorus
Lathyrus brachycalyx†
Viola bellidifolia
Primula incana
Anthopogon thermalis
Castilleja brunnescens†
Plantago Tweedyi
Campanula Parryi
Erigeron consobrinus†
Gnaphalium exilifolium†

Gnaphalium Grayi†
Senecio pudicus†
Senecio anacletus†
Senecio atratus†
Agoseris purpurea†
Agoseris arizonica†
Agoseris attenuata†
Agoseris arachnoidea†
Agoseris maculata†
Agoseris leptocarpa†
Ptilocalais tenuifolia†
Leontodon mexicanus†

G. SALT AND ALKALI MEADOWS

Where the soil contains salt or alkali, the meadow is more or less modified. While the salt and alkali meadows are very common in the Submontane Zone, in the Montane Zone they are uncommon, as the drainage as a rule is much better. In the South Park of Colorado, however, there are salt or alkali meadows of great extent. This may also be the case in the other two large parks. They are common in the St. Louis Valley, but this is mostly below the Montane Zone. The vegetation contains among others the following species:—

Triglochin palustris
Triglochin maritima
Alisma brevipes
Puccinellia Nuttallii
Spartina gracilis
Distichlis stricta
Agropyron Smithii
Agropyron molle
Elymus simplex
Dondia erecta
Sarcobatus vermiculatus
Monolepis Nuttalliana
Ranunculus sceleratus
Halerpestes Cymbalaria
Plantago eriopoda
Arnica foliosa
Tetradymia inermis

H. DRY VALLEYS AND BENCHLANDS

The general description of this formation and a list of the grasses it contains are given in a previous paper.* The list of grasses will here be omitted. The other plants making up the flora are as follows:

I. EASTERN OR TRANSCONTINENTAL

Carex siccata
Polygonum buxiforme
Lepidium densiflorum
Anogra latifolia
Anogra coronopifolia
Plantago Purshii
Plantago eriopoda
Laciniaria punctata
Chrysopsis villosa
Rudbeckia hirta
Solidago glaberrima

* See Bull. Torrey Club 42: 637–638. 1915.

2. WESTERN

Carex Douglasii
Carex Hoodii
Carex phaeocephala
Carex obtusata
Eriogonum stellatum
Eriogonum umbellatum
Arenaria congesta
Arenaria Burkei
Anemone globosa
Thlaspi Nuttallii
Arabis retrofracta
Peritoma serrulatum
Lupinus caespitosus
Lupinus argenteus
Gilia aggregata
Castilleja linearifolia
Aster campestris
Antennaria rosea
Antennaria flavescens
Antennaria concinna
Antennaria oblanceolata
Gymnolomia multiflora
Helianthus petiolaris
Madia glomerata

3. ENDEMIC

Eriogonum (8 species)†
Polygonum Engelmannii
Wahlbergella Drummondii
Wahlbergella comosa
Arenaria (3 species)†
Lepidium (3 species)†
Physaria (3 species)†
Lesquerella montana†
Cheirinia Wheeleri†
Arabis (5 species)†
Arabis Drummondii
Arabis connexa
Potentilla effusa
Potentilla Hippiana
Chamaerhodos Nuttallii
Lupinus aduncus
Aragallus albiflorus
Geranium (3 species)†
Cynomarathrum Nuttallii†
Gilia scariosa†
Gilia candida†
Phacelia glandulosa
Oreocarya thyrsiflora†
Oreocarya virgata†
Lithospermum multiflorum†
Campanula Parryi†
Chrysopsis resinolens
Chrysopsis caudata†
Grindelia erecta
Pyrrocoma (3 species)
Solidago (3 species)
Townsendia grandiflora
Machaeranthera (7 species)†
Erigeron flagellaris
Antennaria (5 species)
Hymenoxis helenioides†
Senecio (8 species)†
Crepis (4 species)

I. GRASSY HILLSIDES

In richer soil the principal grass is *Festuca ingrata*, whose place is taken on the southern slopes of the Southern Rockies by *F. arizonica* and in less degree by *F. Thurberi*. The composition of the flora consists of the following species.

1. EASTERN AND TRANSCONTINENTAL

Calamagrostis purpurascens
Poa crocata
Festuca rubra
Carex concinna
Carex Halleri
Ibidium strictum
Draba nemorosa

2. WESTERN

Carex Rossii
Ibidium porrifolium
Allium Geyeri
Eriogonum ovalifolium
Polygonum sawatchense
Eurotia lanata
Cerastium strictum
Draba nitida
Sieversia grisea
Sieversia ciliata
Collomia linearis
Phacelia sericea
Lappula floribunda
Campanula petiolata
Aster apricus
Macronema suffruticosum
Antennaria pulcherrima
Antennaria anaphaloides
Balsamorrhiza sagittata
Wyethia amplexicaulis
Arnica Parryi
Arnica mollis

3. ENDEMIC

Muhlenbergia (3 species)†
Poa (8 species)†
Festuca ingrata
Festuca saximontana
Festuca (3 other species)†
Allium Brandegei
Allium recurvatum
Erythronium parviflorum†
Erythronium utahense
Cerastium (4 species)
Draba (3 species)
Lesquerella curvipes†
Lithophragma australis†
Potentilla (5 species)
Pachylophus macroglottis
Pachylophus hirsutus
Amarella scopulorum
Dasystephana affinis
Dasystephana Forwoodii
Tessaranthium (5 species)†
Phlox Kelseyi
Mertensia (7 species)†
Valeriana (4 species)†
Solidago (3 species)
Aster andinus
Erigeron viscidus†
Townsendia strigosa†
Helianthella uniflora
Tetraneuris leptoclada
Tetraneuris lanigera
Senecio Fendleri

K. HOG-BACKS AND DRY RIDGES

The flora of the hog backs in the Montane Zone, especially in its upper part, resembles that of the Subalpine Zone; in the lower regions there are many of the species of the dry plains added. Besides these there are a few restricted to the Montane Zone; nearly all of these are endemics. The flora consist of the following:

1. EASTERN OR TRANSCONTINENTAL

Juniperus sibirica
Carex praticola
Carex stenophylla
Calamagrostis purpurascens
Bouteloua gracilis
Koeleria gracilis
Poa crocata

2. WESTERN

Lewisia rediviva
Oreobroma pygmaea
Oreobroma nevadensis
Draba lutea
Sedum stenosepalum
Petrophytum caespitosum
Leptodactylon purgens

3. ENDEMIC

Lesquerella alpina
Eriogonum (6 species)†
Physaria vitulifera
Physaria acutifolia
Trifolium nanum
Trifolium dasyphyllum†
Kentrophyta aculeata
Kentrophyta Wolfii†
Aragallus minor
Phlox depressa
Phlox Kelseyi
Chrysopsis pumila
Townsendia strigosa†
Townsendia montana†
Erigeron ursinus
Antennaria rosulata†
Tetraneuris lanigera†
Tetraneuris brevifolia
Senecio Purshianus
Senecio Fendleri†
Senecio werneriaefolius†

SAND HILLS AND SAND-HILL DRAWS

While the best developed sand and sand-hill draws are found in the region of the Great Plains east of the Rockies, and in the desert plains of the Great Basin west of the same; they are found also in the Submontane and Montane Zones. In the latter the sand-draws are found mostly in the bottoms of the canyons and the

sandhills in the so-called "Parks" of Colorado and in some of the broader river valleys. Most of the species characteristic of both are also found on the Great Plains and are such as have migrated along the rivers to higher altitudes. The following species are components of the flora. None of these are transcontinental or common to the Rockies and the Canadian Zone. A few are common to the Rocky Mountains and the Sierra Nevada Region, but most of them are endemics, either of the Great Plains or the Great Basin, or both.

Eriocoma hymenoides
Muhlenbergia pungens
Stipa speciosa
Oryzopsis Webberi
Sitanion elymoides
Arenaria confusa
Arenaria polycaulos
Peritoma serrulatum
Epilobium paniculatum
Gayophytum intermedium
Gayophytum ramosissimum
Gayophytum racemosum
Nuttallia multiflora
Nuttallia densa
Nuttallia speciosa
Cryptantha Torreyana
Lithospermum multiflorum
Helianthus petiolaris

M. ROCK SLIDES

The rock slide flora of the upper Montane Zone resembles that of the Subalpine, which has already been described.* In lower altitudes the following species appear, all of which are endemic to the Southern Rockies except *Viola biflora*, which is found also in Europe.

Elymus ambiguus†
Aquilegia saximonana†
Aragallus Hallii†
Limnobotrya montigena†
Viola biflora†
Pseudopteryxia anisata†
Pseudopteryxia aletifolia†
Polemonium confertum†
Polemonium mellitum†
Polemonium Brandegei†
Pentstemon stenosepalus†
Senecio Fendleri†
Senecio amplectens†
Senecio canovirens†

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* Bull. Torrey Club 44: 453. 1917.

Studies of West Indian plants—X

Nathaniel Lord Britton

60. UNDESCRIBED SPECIES FROM TRINIDAD

Eleocharis savannarum sp. nov.

Rootstocks very slender, elongated; culms filiform, weak, smooth, 6–15 cm. long, the upper sheath membranous, its mouth oblique; spikelet ovoid, 3–4 mm. long; scales oblong or ovate-oblong, about 2 mm. long, obtuse, nearly white with a greenish midvein; achene trigonous, obovoid, about 0.5 mm. long, truncate; tubercle low, nearly flat, apiculate; bristles none.

Moist hole on the O'Meara Savanna, Trinidad (*Britton 2491*).

Eleocharis oropuchensis sp. nov.

Roots fibrous, finely filiform; culms finely filiform, densely tufted, weak, 5 cm. long or less, the upper sheath membranous, oblique at the summit. Spikelets terminating culms, and sessile at the base of the plant; compressed, 2–3 mm. long, ovate, about 6-flowered; their scales ovate-oblong, pale or brown with pale margins and keel, subdistichous, blunt, 1.5 mm. long; style 3-cleft; achene trigonous, smooth, pale, about 0.5 mm. long, about as long as the 3 or 4 bristles; tubercle conic, one fourth as long as the achene.

In mud in sunny, grassy situations, Trinidad; type from Oropuche Lagoon (*Britton, Hazen and Freeman 1155*, March 29, 1920).

I am indebted to Mr. N. E. Brown for comparing this little plant with West Indian and South American species in the Kew Herbarium, where he was unable to match it. He remarks upon its unusual character of having both terminal and basal spikelets, and compares it with *Chaetocyperus Jamesoni* Steud. from Guayaquil, Ecuador (*Jameson 369*), pointing out important differences, however.

Rynchospora aripoensis sp. nov.

Perennial by short horizontal rootstocks; culms filiform, tufted, smooth, erect, 2–4 dm. high, longer than the filiform leaves. Spikelets few, 2 mm. long, ovoid, acute, 1-fruited, sessile in 1 or 2 small clusters subtended by a filiform bract 1–3 cm. long; scales

ovate, brown, acute; bristles none; achene obovate-elliptic, 1 mm. long, smooth, light brown; tubercle compressed-conic, acute, one third to one half as long as the achene.

Grassy plain, Aripo Savanna, Trinidad (*Britton 2934*). Perhaps most nearly related to *R. Chapmani* M. A. Curtis of the eastern United States.

Bromelia aurea sp. nov.

Leaves numerous, rigid, linear, long-attenuate, 6–8 dm. long, about 3 cm. wide, armed with distant curved prickles 4–5 mm. long. Scape rather slender, shorter than the basal leaves, bearing several prickle-armed small leaves; inflorescence brownish-floccose, about 3 dm. long; bracts lanceolate, membranous, acuminate, 2–4 cm. long; bractlets ovate, membranous, strongly nerved, mucronate, about 1 cm. long; flowers 2 to several together, the clusters 2–3 cm. apart; sepals similar to the bractlets, about 1 cm. long; petals linear, bright yellow, about 3 cm. long and 2 mm. wide.

Wooded hillside, near western end of Monos Island, Trinidad (*Britton, Britton and Brown 2736*). In flower April 4, 1921. Related to *B. chrysantha* Jacq. of Venezuela.

Aechmea porteoides sp. nov.

Leaves firm in texture, linear with a somewhat broadened base, about 8 dm. long, 4–7 cm. wide, sharply acute, the margins armed with very numerous, approximate, nearly black, slightly curved spinules 4 mm. long or less; inflorescence paniculate, as long as the leaves or longer, its ultimate branches spreading, about 6 cm. long, stellate-pubescent, slender, few-flowered; bracteoles subulate-acicular, 4–6 mm. long; flowers blue, about 20 mm. long; sepals striate, about 1 cm. long, with a terminal spinule 2–3 mm. long; ovary about 1 cm. long, oblong.

On the ground in mountain forests, Trinidad. Type from Mount Tocuche (*Britton, Hazen and Mendelson 1342*). In flower April 5, 1920. Related to *A. Fendleri* of Venezuela.

Tillandsia viscidula sp. nov.

Basal leaves tufted, linear, 2.5–3.5 dm. long, flat, gradually narrowed upward, abruptly contracted at the apex and short-acuminate, the base expanded and dark-blotched. Stem 3–5 dm. high, erect, bearing leaves similar to the basal ones, but smaller, the upper ones 7 cm. long or less; panicle 3–5 dm. long, few- to several-branched, viscid; flowers yellow, distant, sessile, about 2

cm. long, at first appressed, later spreading, about as long as the bracts.

On trees, Trinidad. Type from Moruga (*Britton and Broadway 2430*). Related to *T. aloifolia* Hook.

Alpinia silvicola sp. nov.

Rootstocks rather stout, scaly. Sterile stem 2–3 m. high; leafy; leaves oblong, thin, glabrous, closely many-veined, 3–5 dm. long, 6–10 cm. wide, the apex acuminate, the base narrowed, the petioles 1–2.5 cm. long, the sheaths striate; lower leaves reduced to thin sheathing scales. Fertile stems about 3 dm. high, pubescent above, with a few, narrow scales 3–4 cm. long; spike dense, several- to many-flowered, 7–10 cm. long; bracts 1-flowered, shorter than the flowers; calyx about 1.5 mm. long, pubescent, its lobes broad; corolla yellow, about 2 cm. long; fruit oblong, about 3 cm. long, its juice blue-black.

Forests of the northern mountain range, Trinidad. Type from Mount Tocuche (*Britton, Hazen and Mendelson 1301*).

Calathea trinitensis sp. nov.

Leaves erect, oblong to oblong-lanceolate, glabrous, the blade up to 1 m. long and 3 dm. wide, rather shorter than the slender petiole, rather abruptly narrowed at the base, the apex abruptly tipped, the midvein prominent, the innumerable lateral veins close together. Scape glabrous, about 7 dm. high; spike dense, about 2 dm. long; bracts oblique, many-veined, 3–4 cm. long, their spreading tips acute; flowers yellow, about 3 cm. long, the segments linear, parallel-veined, acute.

Forest, heights of Aripo, Trinidad (*Britton and Freeman 2360*). In flower March 16, 1921.

Ficus ierensis sp. nov.

A tree up to 10 m. high or higher, glabrous. Leaves broadly elliptic or elliptic-orbicular, subcoriaceous, pinnately 5- to 9-veined on each side of the rather prominent midvein, rounded at the apex, cordate at the base, 10–20 cm. long, the stout petiole one fourth to one third as long as the blade; fruiting peduncles slender, about 1 cm. long; fruit globose, 12–18 mm. in diameter; bracts 2 or 3, broad, rounded, nearly as long as the fruit; ostiolum sunken, about 2 mm. in diameter.

Hillsides in relatively dry districts, Trinidad. Type from North Post Road (*Britton, Hazen and Mendelson 774*). Similar

to *F. crassinervia* of Hispaniola, to which species it has been referred, and also related to *F. Urbaniana* Warburg, of the Lesser Antilles.

Ficus arimensis sp. nov.

Twigs stout. Leaf-blades firm in texture, obovate, about 2 dm. long and twice as long as wide, distantly pinnately veined, the base subcuneate, the apex rounded and short-cuspidate; fruit subglobose, sessile, about 8 mm. in diameter (immature).

Arima, Trinidad (*J. Dannouse*). Collected in 1905.

Ficus Mendelsonii sp. nov.

A tree up to 16 m. high. Leaves elliptic to obovate-elliptic, the blade thin, smooth, 10–15 cm. long, about twice as long as wide, distantly pinnately veined, triple-veined just above the base, the base rounded or obtuse, the apex abruptly short-acuminate; petioles slender, 2–6 cm. long; peduncles slender, 1–2 cm. long; fruit globose, pale, 10–15 mm. in diameter, the ostiolum deeply concave; basal bracts 2, triangular-ovate, about 2 mm. long.

Forests in moist or wet districts, Trinidad. Type from the northern hills between North Post and Maqueripe (*Britton, Hazen and Mendelson 879*).

Phoradendron chaguaramasanum Trelease sp. nov.

Scarcely forked, the moderate branches with basal cataphyls only, androgynous?. Internodes short (2 × 10–30 mm.), at first papillately roughened, quadrangular and somewhat 4-winged, little flattened. Cataphyls a single pair, nearly basal, deeply notched. Leaves spatulate-oblong, obtuse to subtruncate, scarcely 1 × 2.5 cm., cuneately subpetioled for 5 mm., fleshy, drying yellow, 1- or obscurely 3-nerved from the base. Spikes solitary, very short (about 5 mm.), with 2 or 3 very short characteristically 4-flowered joints; peduncle about 1 mm. long; scales ciliolate. Immature fruit subglobose, scarcely 2 mm. in diameter, reddish, verrucose; sepals yellow, erect, not meeting.

Chaguaramas, Trinidad (*Britton 2718*, the type, April 4, 1921).

Phoradendron caerulescens Trelease sp. nov.

Pseudodichotomous, the moderate branches with basal cataphyls only, androgynous?. Internodes short (2–3 × 10–20 mm.), smooth, glossy, quadrate, the upper ancipitally dilated to a width of 4 mm. below the nodes. Cataphyls a single pair, basal, glossy brown, tubular-bifid. Leaves round-elliptical, submucronately

acuminate, 1.5 × 2–2.5 cm., cuneately subpetioled for about 5 mm., cartilaginous-margined, about 5-nerved, at first delicately blue-glaucous. Spikes solitary, short (scarcely 15 mm.) with 3 or 4 short 4-flowered joints; peduncle 1 mm. long; scales slightly ciliolate. Fruit (immature) small, globose, deeply immersed, verrucose: sepals inflexed.

Chacachacare Island, Trinidad (*Britton and Hazen 1726*, April 13, 1920), the type; also from the same locality, on *Capparis* (*Britton, Freeman and Watts 2701, 2708*, 1921).

Of the *Emarginatae*, but with inflexed sepals, and in this, as well as in its flattened twigs, related to *P. Ottonis* Eichler of Venezuela.

Seguiera ierensis sp. nov.

A climber with slender twigs and branches, the prickles 2–25 mm. long. Leaves oblong or oblong-lanceolate, 6–16 cm. long, acute or acuminate at the apex, narrowed or obtuse at the base, or the upper ones smaller and obtuse, the petioles 2–7 mm. long; panicles many-flowered, 5 9 cm. long, puberulent; pedicels 2–3 mm. long; perianth-segments unequal, elliptic to obovate, 3–3.6 mm. long, rounded, concave; stamens about 20 with filiform filaments and linear anthers.

McBean Estate, Carapachaima, Trinidad, April 30, 1918 (type). Forest, Ortoire River, Guayaguayare Road (*Britton, Freeman and Nowell 2527*, barren).

Seguiera cordata sp. nov.

Twigs slender; prickles stiff, nearly straight, about 8 mm. long. Leaves broadly ovate, subcoriaceous, glabrous, 14 cm. long or less, cordate or subcordate at the base, acute at the apex, or small ones obtuse at both ends, the venation prominent beneath, impressed above, the stout petioles 6–8 mm. long; panicles many-flowered, about 6 cm. long; bractlets ovate, 1 mm. long, about as long as the pedicels or a little shorter; sepals 1–1.5 mm. long.

Lobajos near Erin, Trinidad (*Trinidad Herbarium 9122, W. E. Broadway*, May 14, 1920).

Chrysobalanus savannarum sp. nov.

An irregularly branching shrub 0.5–4 m. high, the glabrous twigs slender. Leaves obovate to elliptic-obovate, 1.5–3.5 cm. long, strongly reticulate-veined above, faintly veined beneath, obtuse or acutish at the apex, narrowed at the base, the petioles 1.5–2

mm. long; flowers few, in small axillary clusters not longer than the leaves, or these terminating short leafy twigs; pedicels short, puberulent; calyx silky-pubescent, its lobes short, broad, obtuse; petals cuneate-spatulate, rounded at the apex, 3–3.5 mm. long; drupe oblong or narrowly oblong-obovoid, obtuse, about 8 mm. long and 4 mm. in diameter.

Grassy plain, Aripo Savanna, Trinidad (*Britton, Hazen and Freeman 2005*, April 21, 1920).

Acacia quadricostata sp. nov.

A woody vine, up to 8 m. long, the old stems 4-ribbed or 4-flanged, about 8 cm. thick near the base, the twigs 4-angled, armed with recurved prickles about 3 mm. long. Leaves 2-pinnate, 6–17 cm. long; stipules wanting; petiole slender, bearing a sessile, circular gland; rachis glabrous, sometimes bearing a few minute prickles; rachilla very slender, angular; leaflets 35 pairs or fewer, sessile, linear-lanceolate, acutish, 6–8 mm. long, about 1 mm. wide, truncately inequilateral at the base, the midvein somewhat eccentric, the lateral veins few, glabrous, except for a characteristic line of yellowish hairs on the underside of the midvein near the base; legume linear-oblong, flat, densely puberulent, 5–9 cm. long, nearly 2 cm. wide, narrowed at the base with a short stipe, acute and short-tipped; seeds orbicular, dark brown, about 7 mm. in diameter.

Hillside, Chacachacare Island, Trinidad (*Britton, Freeman and Watts 2685*), in fruit April 3, 1921. The prickles are persistent upon the old stems and branches.

Erythrina pallida Britton and Rose sp. nov.

A small tree, 4 meters high; young growth puberulent; second year growth glabrate with shining gray bark; spines at base of leaves stout, reflexed, 6–8 mm. long; leaves large; rachis 2 cm. long or more, glabrous; leaflets 3, broadly ovate, sometimes obliquely so, acuminate, 12–15 cm. long, green above, very pale beneath, glabrous on both sides at least when mature; inflorescence subsessile, paniculate, 1–2 dm. long; pedicels stout, about 1 cm. long; calyx 1.5 cm. long, nearly truncate, except a small protuberance on the lower side; corolla salmon-colored, narrow, 7 cm. long; fruit with a long slender stipe 3 cm. long; tipped with a rigid persistent style, 2 cm. long, moniliform, 8–10-seeded; seed 8 mm. long, 6 mm. broad.

Hillsides and roadsides, Trinidad. Type from roadside near Carenage (*Britton 2656*), April 4, 1921. Commonly planted as a fence tree in Trinidad.

Elaphrium trinitensis Rose sp. nov.

A gnarled tree, 5 meters high, fragrant; branches glabrous, often short and spur-like, with brownish bark; leaves simple, borne at the end of stubby branches, the petiole not winged, 12 mm. long or less, the blade broadly ovate, 2.5 cm. long or less, entire, glabrous; flowers solitary or in small panicles sometimes only 3- or 4-flowered; pedicels 3 to 5 mm. long, glabrous; fruit 3-angled, glabrous, 8 to 10 mm. long; nutlet white, 3-angled.

Western end of Monos Island, Trinidad (*Britton, Britton and Brown 2739*), April 4, 1921.

Phyllanthus graminicola sp. nov.

Annual, with fibrous roots, glabrous; stem slender, erect, becoming much branched, 1–3 dm. high, the branches almost filiform. Leaves oblong-elliptic, thin, faintly pinnately veined, 4–10 mm. long, the apex obtuse, the base more or less narrowed, the petiole about 1 mm. long; stipules minute; flowers nearly sessile; calyx of the pistillate flowers deeply 6-parted, the linear segments at length about 1 mm. long; fruit depressed, 1.5 mm. in diameter; seeds about 0.6 mm. long.

Moist grassy situations at low elevations, Trinidad. Type from grassy roadside, Carenage (*Britton and Hazen 12*). In fruit February 25, 1920. Related to *P. carolinensis* Walt. of the eastern United States, which has larger fruit and seeds and broader pistillate calyx-segments.

Clusia tocuchensis sp. nov.

A tree about 18 m. high, the twigs rather stout. Leaves borne at the ends of the twigs, obovate, coriaceous, glabrous, about 10 cm. long, 4–5 cm. wide, rounded at the apex, cuneate at the base, rather finely pinnately veined, the short stout petiole only about 5 mm. long; fruit globose, 10–15 mm. in diameter; carpels about 7; styles stout, 3–4 mm. long; stigmas flat, obliquely oblong, the center depressed.

Forest, Mount Tocuche, Trinidad (*Britton, Hazen and Mendelson 1247*). In fruit April 3–5, 1920.

Terminalia nyssaefolia sp. nov.

A tree up to 20 m. high, the slender twigs glabrous. Leaves chartaceous, obovate, 7–12 cm. long, 4–6 cm. wide, entire, abruptly short-acuminate at the apex, cuneate at the base, strongly

reticulate-veined, glabrous and bright green above, pale green, dull and strigose-pubescent on the veins beneath, the strigose and ciliate petioles 5–10 mm. long; fruit compressed, 2-winged, broader than long, 2–3.5 cm. broad, 1.5–2.5 cm. long, notched at the apex, at base abruptly contracted into a stalk about 2 mm. long, the thin striate wings about one half as wide as the seed-bearing part.

Coastal woods, Manzanilla, Trinidad (*Britton 2177*). In fruit (fruit fallen) March 9, 1921.

Combretum trinitense sp. nov.

Vine-like, woody, the stems up to 6 m. long, the branches long and slender, the twigs glandular. Leaves elliptic or elliptic-lanceolate, chartaceous, 8–12 cm. long, 5 cm. wide or less, the midvein prominent beneath, impressed above, the lateral veins about 7 on each side of the midvein, slender, curved upwardly, the upper surface glabrous, reticulate-veined, the under surface impressed-glandular, the glandular petioles 6–7 mm. long; fruiting racemes 6–10 cm. long; fruit oblong, 10–15 mm. long, the four thin wings glandular, the pedicels about 2 mm. long.

Hillside thicket, Chacachacare Island, Trinidad (*Britton, Freeman and Watts 2699*). In fruit April 3, 1921.

Myrcia arimensis sp. nov.

A small tree, the slender young twigs rather densely strigose. Leaves elliptic to elliptic-ovate, chartaceous, 4–6 cm. long, reticulate-veined, punctate, dark green and shining above, pale green beneath, the apex acute, the base narrowed, the strigose or glabrate petioles 3–5 mm. long; panicles several- to many-flowered, 5–7 cm. long, their slender branches spreading; flowers nearly or quite sessile; calyx-lobes rounded; immature fruit globose, about 5 mm. in diameter.

Arima, Trinidad (*J. Dannouse*, Feb. 10, 1905).

Eugenia Baileyi sp. nov.

A tree up to 12 m. high or higher, the twigs terete, rather slender. Leaves coriaceous, glabrous, broadly elliptic, 12–16 cm. long, 9–12 cm. wide, rounded at the apex, obtuse at the base, strongly pinnately veined, abundantly punctate, the stout petioles 1–1.5 cm. long; fruit lateral, oblong or ovoid-oblong, about 2 cm. long and 1 cm. thick, pale, puberulent, nearly sessile.

Forest, Morne Bleu, Trinidad (*Britton, Freeman and Bailey 2246*). In fruit March 13, 1921.

Hydrocotyle Hazenii Rose sp. nov.

A delicate creeping plant, rooting at the nodes; petioles slender, 2 to 5 cm. long, pubescent and more pronounced just below the blade; blade nearly orbicular, 2.5 cm. in diameter or less, glabrous and paler beneath, somewhat hairy or glabrate above, the sinus usually narrow, the margins doubly crenate, the crenations low and broad; peduncle slender, hairy above, longer than the petiole; flowers in a small compact umbel; pedicels 1 to 2 mm. long.

Among wet rocks, Maracas Waterfall, Trinidad (*Britton, Hazen and Mendelson 1660*, April 10, 1920).

Psammisia recurvata sp. nov.

Stems branched, about 5 m. long. Leaves coriaceous, glabrous, elliptic-ovate, 10–20 cm. long, 7–10 cm. wide, pinnately 7-veined from near the base, with numerous curved transverse veinlets, the venation impressed above, prominent beneath, the apex acute, the base narrowed, the stout petiole 1–2 cm. long; flowers several in short axillary racemes; bractlets ovate, acute, about 2 mm. long; pedicels stout, recurved, glabrous, 2–3 cm. long; ovary subglobose, glabrous; calyx subcampanulate, persistent, about 6 mm. long in fruit, its lobes rounded, apiculate, their margins thickened; corolla-tube about 4 cm. long, red, the short limb white; fruit globose, about 1 cm. in diameter, many-seeded.

Forest bank, near summit of Mount Tocuche, Trinidad (*Britton, Hazen and Mendelson 1294*).

Specimens of this plant were mixed by Grisebach with those of another and the complex described by him (Fl. Br. W. I. 143) as *Thibaudia latifolia* Griseb., subsequently referred by Bentham and Hooker to *Vaccinium*; it would appear that the name *latifolia* should go with this other species, which, however, is not a good *Vaccinium*.

Sophoclesia trinitensis sp. nov.

Pendent from forest trees; stem slender, sparingly branched, short-villous when young, 1–4 m. long. Leaves subcoriaceous, glabrous or nearly so, ovate or some of them ovate-lanceolate, 1.5–3.5 cm. long, from about one half to two thirds as wide as long, triplinerved with a pair of delicate veins at the base, this venation rather distinct beneath, obscure above, the apex bluntly pointed, the base rounded or subtruncate, the villous petiole about 2 mm. long; peduncles filiform, glabrous, somewhat shorter than the leaves; ovary globose, glabrous or with a few hairs; corolla white,

glabrous, about 5 mm. long; fruit blue or mauve, glabrous, about 5 mm. in diameter.

Forests, in wet districts, Trinidad. Type from Mount Tocuche (*Britton, Hazen and Mendelson 1316*). In flower and fruit April 3, 1920.

Sophoclesia major (Griseb.) Benth. & Hook., also of Trinidad, differs in its ovate-orbicular rounded, subcordate leaves and densely pilose ovary.

Cavendishia Urichiana sp. nov.

A much-branched, woody vine, up to 6 m. long, glabrous throughout, the branches slender. Leaves oblong-lanceolate to oblong-elliptic, somewhat fleshy, dark green above, bright green beneath, chartaceous in drying, triple-nerved, 10–15 cm. long, 3–5 cm. wide, the nerves rather prominent beneath, slightly impressed above, the apex acuminate, the base narrowed, the petiole 8–10 mm. long, rather stout; flowers fascicled on the twigs or in the leaf-axils, bracteolate, the bractlets ovate, acute, 2–3 mm. long; pedicels slender, 8–20 mm. long; calyx-limb with 5 short acute teeth, expanded above the ovary; corolla-tube sub-cylindric, about 2 cm. long, scarlet, the limb 4 mm. long, white, with 5 ovate-lanceolate teeth; stamens shorter than the corolla; style slender, exserted; immature fruit subglobose, crowned by the calyx-limb.

Climbing on forest trees, Heights of Aripo, Trinidad (*Britton and Freeman 2364*, March 16, 1921). Specimens were brought from the same place a few days earlier by Mr. F. W. Urich, Entomologist of the Trinidad Department of Agriculture, and he guided us to it. The plant from which the type specimens were taken is wonderfully elegant when in bloom, displaying long wands of the scarlet, white-tipped flowers, and is locally called "clove-plant."

Diospyros ierensis sp. nov.

A tree, 12 m. high or higher, the twigs and leaves glabrous. Leaves chartaceous, oblong to elliptic, 10–15 cm. long, 7 cm. wide or less, bluntly short-acuminate at the apex, narrowed or obtuse at the base, reticulate-veined, the venation prominent beneath, the stout petiole 10–14 mm. long; fruiting calyx 2–2.5 cm. broad, nearly flat, wrinkled, 4-lobed, the lobes broad and short; fruit subglobose, about 4 cm. in diameter (not quite mature); seeds about 8.

Forest near the summit of Mount Tocuche, Trinidad (*Britton, Hazen and Mendelson 1243*). In fruit April 5, 1920.

Specimens collected by J. Dannouse at Guanapo, Trinidad, showing imperfect flowers about 1 cm. wide (*Trinidad Herb. 6415*) are probably referable to this species.

Chrysophyllum (?) **minutiflorum** sp. nov.

A tree about 15 m. high, the young leaf-buds puberulent, otherwise glabrous. Leaves thin-chartaceous, oblong-lanceolate, 13 cm. long or less, 2.5–5 cm. wide, long-acuminate at the apex, narrowed at the base, delicately pinnately and reticulate-veined, the rather slender petioles 10–15 mm. long; flowers green, several to many in sessile axillary fascicles; bractlets minute; pedicels very slender, thickened upward, 5–8 mm. long; calyx about 1.5 mm. long, its 3 or 4 lobes rounded; corolla-segments 3 or 4, minute; stamens 3 or 4.

Forest, Arima, Trinidad (*Britton, Britton and Brown 2403*). In young flower March 18, 1921.

The flowers are too young to enable the generic status of this tree to be certainly determined. Mr. N. E. Brown has identified specimens as the same as Crueger's *no. 247* in the Kew Herbarium, from Trinidad, which is a leafy branch and a detached fruit. The leaves are also the same as those of Trinidad Herbarium *no. 1454*, also leafy shoots with the remains of a fruit which was, apparently, about 2 cm. long, attached, and with some flowers even younger than those of our *2403*.

Evolvulus bocasanus sp. nov.

Perennial, shrubby, branched, 3–4 dm. high, the branches nearly erect or ascending, strigose. Leaves lanceolate to oblong, 2–5 cm. long, 5–15 mm. wide, strigose on both sides, acute or obtuse at apex, obtuse at base, pinnately few-veined, the veins nearly parallel, the petiole 1–2 mm. long; peduncles filiform, axillary, 3 cm. long or less, 1–few-flowered; bracts lanceolate, acuminate, 2–3 mm. long; pedicels 2–10 mm. long; calyx strigose, 3–4 mm. long, 5-lobed to about the middle, the lobes lanceolate, acute; corolla rotate, bright blue, 8–15 mm. broad.

Hillsides, Bocas Islands, Trinidad; type from Chacachacare (*Britton, Freeman and Watts 2674*). In flower April 3, 1921. This is the species recorded from Trinidad by Grisebach as *Evolvulus alsinoides* L., at least in part.

Solanum ierense sp. nov.

A shrub about 2 m. high, the slender unarmed branches divergent, glabrous, the young twigs stellate-pubescent. Leaves thin, ovate or elliptic-ovate, 5 cm. long or less, delicately pinnately few-veined, sparingly stellate-pubescent above, densely stellate-pubescent beneath, the apex acute or obtuse, the base obtuse or narrowed, the slender petioles 4–10 mm. long; flowers solitary or geminate (rarely 3) in the axils on nearly filiform pubescent peduncles 2.5 cm. long or less; calyx stellate-pubescent, 5–7-cleft, the lobes linear-lanceolate, acuminate; corolla white, 5–6-cleft, its lobes linear-lanceolate, acuminate, 10 mm. long; stamens 5 or 6, all alike, the anthers somewhat attenuate, 8 mm. long, the filaments 1–2 mm. long; immature berry globose, about 7 mm. in diameter.

Hillside, Chacachacare, Trinidad (*Britton, Freeman and Watts 2706*). In flower and young fruit April 3, 1921.

Solanum Hazenii sp. nov.

A tree up to about 5 m. high with a woody trunk about 1.5 dm. in diameter. Leaves broadly elliptic, rather thin and flaccid, 10–20 cm. long, 8–15 cm. wide, strongly pinnately veined on the under side, the apex short-acuminate, the base obtuse, the upper surface finely stellate when young, glabrous when old, the under surface persistently stellate-tomentulose, the stout, stellate-tomentulose petioles 3 or 4 cm. long; inflorescence stalked, about equalling the leaves, many-flowered, tomentulose; pedicels short; flower-buds subglobose, rounded, tomentulose; calyx tomentulose, deeply lobed, 5 mm. long, the lobes obtuse; corolla white, 20 mm. broad, 5-lobed to below the middle, the lobes broadly ovate, acute; stamens all alike, the anthers 3 mm. long, about twice as long as the filaments; berry globose, black, about 8 mm. in diameter.

Hillsides, northwestern parts of Trinidad mainland and on the adjacent Bocas Islands. Type from Saddle Road (*Britton and Hazen 156*).

Solanum capillipes sp. nov

A shrub, about 2 m. high, the slender young branches pilose, the older branches glabrous. Leaves oblong-elliptic to elliptic-lanceolate, membranous, all alike, pinnately veined, glabrous, somewhat darker green above than beneath, 10–15 cm. long, 3–6 cm. wide, acuminate, the slightly inequilateral base narrowed, the petioles about 1 cm. long; racemes lateral, few-flowered,

glabrous; peduncles very slender, 2.5 cm. long or less; pedicels filiform, spreading, 1–3 cm. long; calyx obconic, about 5 mm. long; corolla white, deeply lobed, 5–6 mm. broad; stamens all alike, the oblong anthers obtuse, 1.5 mm. long, nearly sessile; fruit globose, 6–7 mm. in diameter.

Forests in wet districts, southern Trinidad. Type from forest, Ortoire River, Guayaguayare Road (*Britton, Freeman & Nowell 2521*).

Codonanthe (?) **triplinervia** sp. nov.

A somewhat fleshy, epiphytic woody vine, 1–2 m. long, the young twigs sparingly pubescent. Leaves ovate or ovate-lanceolate, 8 cm. long or less, 2–3.5 cm. wide, glabrous, rather thin, triplinerved, the apex acuminate, the base narrowed or obtuse, the slender, sparingly pubescent petioles 6–12 mm. long; flowers solitary or 2–4 together at the nodes; bractlets linear, pubescent, acute, 6 mm. long or less; pedicels slender, pubescent, about as long as the bractlets; calyx 10–12 mm. long, sparingly pubescent below, deeply cleft, its segments linear-oblong, acute; corolla 3–3.5 cm. long, white, the throat yellow within, its tube slightly bent just above the gibbous base, about 1 cm. long, the subcampanulate throat about 1.5 cm. long, the somewhat spreading limb with rounded, translucent lobes.

On forest trees, Trinidad; type from Ortoire River, Guayaguayare Road (*Britton, Freeman and Nowell 2543*). In flower March 25, 1921.

Sabicea trinitensis Standl. sp. nov.

Vine, the stems about 2 m. long, pubescent with dense short ascending rufescent hairs; stipules 5–6 mm. long, rounded-ovate, obtuse or subacute, finely ciliolate but otherwise glabrous; petioles 8–14 mm. long, densely hirtellous with ascending hairs; leaf-blades elliptic or oblong-elliptic, 9–10.5 cm. long, 4.5–6 cm. wide, acute or subacute, abruptly contracted at base, hispidulous above along the costa, elsewhere scaberulous, appressed-pilose beneath along the veins, glabrate elsewhere; flowers few, sessile in the leaf-axils, subtended by two green bracts similar to the stipules; hypanthium about 3 mm. long; glabrous or with a few appressed white hairs; calyx-lobes linear, 2–3 mm. long, green, plane, obscurely ciliolate; corolla appressed-hirsute, the tube 6–7 mm. long, the lobes lanceolate, acuminate, 3 mm. long.

Type in the U. S. National Herbarium, No. 1,059,334, collected in a thicket of the O'Meara Savanna, Trinidad, March 22, 1921 (*Britton 2489*).

The proposed species is most nearly related to *S. hirsuta adpressa* Wernham, which has been reported from Trinidad. It differs essentially, however, in the short narrow calyx-lobes and in the short scant pubescence of the upper leaf-surface.

61. UNDESCRIBED SPECIES FROM JAMAICA

Pilea Maxoni sp. nov.

Stem trailing, freely rooting at the nodes, 3–6 dm. long or longer, rather densely pubescent, the pubescent branches erect, 6–12 cm. high or higher. Stipules ovate-orbicular, rounded, submembranous, 3–6 mm. long, sometimes broader than long; leaf-pairs nearly equal; leaves ovate, regularly crenate, 1–3 cm. long, acute, acuminate, or some of the smaller ones obtuse at the apex, obliquely obtuse or rounded at the base, 3-nerved from above the base, sparingly pubescent and reticulate-veined beneath, the upper surface nearly veinless, with long, flat scattered hairs and some short ones, the linear glochides largely marginal only; petioles slender, pubescent, as long as the blades or shorter; pistillate inflorescence paniculate, slender-peduncled, about 6 cm. long, the staminate shorter; sepals lanceolate or oblong-lanceolate.

Rocky woods in the Cockpit Country, Jamaica. Type, *Maxon & Killip 1555*, from near Mocho, above Catadupa, April 3, 1920; previously collected near Troy, June 28, 1904 (*Maxon 2834*), our specimen of this number barren.

Zanthoxylum Harrisii P. Wilson sp. nov.

An unarmed tree 15–18 m. high, with grayish-brown branches. Leaves equally pinnate, 2–3.5 dm. long, the petioles and rachis terete, glabrous or nearly so; leaflets 8–12, alternate or sometimes opposite, short-petioluled, elliptic-lanceolate to elliptic, 7–15 cm. long, 4–5 cm. broad, coriaceous, acuminate at the apex, inequilateral at the base, entire, lustrous above, the midvein impressed, paler beneath, the midvein prominent; inflorescence terminal or lateral in the axils of the upper leaves, the branches densely puberulent; staminate flowers: calyx lobes 5, triangular-ovate; petals 5, lanceolate, 3 mm. long, 1.5 mm. broad, stamens 5, exserted.

St. George's, Portland, Jamaica, March 30, 1918 (*Harris 12878*).

Salvia clarendonensis sp. nov.

A spreading shrub with weak stems and branches 2–3 m. long, the twigs, petioles and inflorescence puberulent. Leaves slender-

petioled, membranous, oblong-lanceolate, serrulate, glabrous above, puberulent beneath, acuminate at the apex, narrowed or obtuse at the base, 5–15 cm. long; racemes slender, 7–10 cm. long; bracts linear-lanceolate, the lower ones sometimes 1 cm. long; pedicels very short; calyx about 5 mm. long, its ovate cuspidate teeth shorter than the tube; corolla rose-purple, 1–1.2 cm. long.

Peckham woods, Upper Clarendon, Jamaica (*Harris 12787*).

Gesneria jamaicensis sp. nov.

A glabrous shrub, up to 3.3 m. high, the young twigs and leaves resiniferous, the branches terete. Leaves oblong to elliptic, subcoriaceous, 7–12 cm. long, 2.5–5 cm. wide, acute or acuminate at the apex, closely serrate except near the entire, acute or acutish base, pinnately veined, the rather stout petioles 5–10 mm. long; peduncles axillary, slender, 1-flowered, about as long as the leaves; calyx-tube obconic or turbinate, 6–8 mm. long; calyx-lobes linear-lanceolate, bluntish, 8–10 mm. long, 1 mm. wide; corolla crimson or rose-pink, its tube subcylindric, 8–10 mm. long, its spreading lobes orbicular, strongly veined, erose, about 4 mm. broad; stamens included; filaments distinct, about 8 mm. long; anthers nodding; staminodium a little shorter than the filaments; style glabrous, 2-lobed; capsule broadly turbinate, about 8 mm. long.

Ipswich, St. Elizabeth, Jamaica (*Harris 12509*, type); Mulgrave, St. Elizabeth, Jamaica (*Harris 12374*).

Nearest related to *G. Harrisii* Urban, which has a sulphur-yellow corolla with oval lobes, the calyx-lobes filiform, the leaves crenate-dentate.

62. UNDESCRIBED SPECIES FROM CUBA

Scleria motemboensis sp. nov.

Annual with fibrous roots; culms solitary or few together, slender, erect, villous, about 3 dm. high. Leaves narrowly linear, villous, 1–1.5 mm. wide; inflorescence glomerate-spicate; glomerules of 2 or 3 sessile spikelets; bracts linear, long-ciliate, 3–4 mm. long; achene white, shining, 1.5 mm. in diameter, apiculate, faintly longitudinally striate, with 4 pores at each side of the subtrigonous base.

Small lagoon, Sabana de Motembo, Santa Clara, Cuba (*Léon and Loustalot 9405*). Nearest to *S. Lindleyana* Clarke of South America.

Ouratea savannarum Britton & Wilson sp. nov.

A glabrous shrub 5 m. high, the slender twigs grayish-brown, often somewhat flexuose. Leaves coriaceous, elliptic-lanceolate to elliptic-ovate, 4–8 cm. long, 2–3.8 cm. broad, acuminate at the apex, rounded at the base, faintly pinnately nerved, the margin spinose-serrate; petioles short, stout, 3–4 mm. long; inflorescence terminal, 6–11 cm. long; pedicels slender, 1–1.5 cm. long; buds ovoid; sepals oblong-lanceolate to oblong-elliptic, 7–7.5 mm. long, 3.2–3.5 mm. broad, obtuse at the apex; petals obovate, 9 mm. long, 7 mm. broad, crenulate; anthers oblong-lanceolate or oblong, 2.5 mm. long, subsessile; style 6–7 mm. long; fruit unknown.

Sabana de San Marcos, Santa Clara, Cuba (*Léon 9205*).

Banara Brittonii Roig sp. nov.

A slender shrub about 4 m. high, the young twigs densely pubescent. Leaves oblong to oblong-lanceolate or ovate-lanceolate, 4–7 cm. long, 1.5–3 cm. wide, acute at the apex, more or less inequilateral and rounded at the base, glabrous and shining above, reticulate-veined and densely pubescent beneath with short, whitish, mostly appressed hairs, the margin revolute, serrulate; petioles 5–8 mm. long, slender, with one or two orbicular glands at the summit; inflorescence terminal, inclined or pendulous, 5–7 cm. long, the branches puberulent, pedicels slender, 3–5 mm. long; sepals oblong-elliptic to oblong-ovate, 2.5 mm. long, obtuse at the apex, the margin ciliate; petals oval to suborbicular, about as long as the sepals, yellow; stamens indefinite; anthers rounded; style 1.5 mm. long; fruit globose (immature?), 4 mm. in diameter, becoming black in drying.

Rocky limestone soil, Cayo Mono, inside the swamp near San Pedro, Isle of Pines (*M. Cremata*, May 17, 1920).

Psidium Loustalotii Britton & Wilson sp. nov.

A small shrub, with short, grayish, often spine-like twigs. Leaves elliptic to oval, 2–4 mm. long, 1.5–3 mm. broad, rounded at both ends, dark green and more or less minutely hispidulous above, paler and strigillose beneath, coriaceous, the short petiole 0.5 mm. long or less; pedicels axillary, solitary, 2 mm. long; young fruit ellipsoid, 5 mm. long, 4 mm. in diameter, black.

Sabana de Motembo, Santa Clara, Cuba (*Léon & Loustalot 9394*).

Jacquinia Roigii P. Wilson sp. nov.

Shrub or tree?; twigs and branches glabrous. Leaves obovate, 4–8 cm. long, 1.4–2.7 cm. broad, strongly spine-tipped at the apex,

cuneate at the base, 3-nerved, in whorls of 4 or more with distinct internodes between the whorls; pedicels 3.5 cm. long; sepals long-ciliate; fruit ellipsoid, 1.7 cm. long, 1.1 cm. broad.

Cañete, Oriente, Cuba (*J. T. Roig 69*).

Tabebuia saxicola sp. nov.

A much-branched shrub, about 3 m. high, the short, stiff twigs white-lepidote. Leaves simple, entire, oblong or oblong-lanceolate, 2–4 cm. long, 5–11 mm. wide, acute at the apex, narrowed at the base, the upper surface pale green, loosely lepidote and with very obscure venation, the under-surface reticulate-veined and densely white-lepidote, the petioles 1–3 mm. long; flowers solitary or 2 together at the ends of short twigs; peduncles 1 cm. long or less; calyx narrowly campanulate, lepidote, persistent, about 7 mm. long, irregularly toothed; corolla 2–2.5 cm. long; capsule 4–5 cm. long, about 8 mm. thick.

Rocky top of highest mogote near Sagua la Grande, Santa Clara, Cuba (*Léon and Loustalot 9477*). In both flower and fruit August 12, 1920.

63. A NEW TOURNEFORTIA

Tournefortia barbadensis N. E. Brown

Stem probably scrambling, with the young parts minutely adpressed-puberulous. Leaves very spreading; petiole about 3 lines long; blade 1½–2¾ in. long and 6–10 lines broad, lanceolate, gradually tapering from about the middle to an acute apex, subacute or slightly rounded at the base, glabrous above, thinly and microscopically puberulous beneath. Cymes lateral below the ends of the branches, 2–3½ in. in diameter, on peduncles 3–5 lines long, lax, with the primary and sometimes the secondary forkings subhorizontally diverging, then branching in a zigzag manner, minutely adpressed-puberulous; branches about 3 lines apart and ⅓ in. long, very slender, variously curved, with the small slender flowers about 1 line apart. Pedicels ¼–½ line long. Calyx very small, about ½ line long, lobed almost to the base; lobes subulate or deltoid-subulate. Corolla minutely puberulous outside, with a rather slender tube about 1¼ line long, swollen at the upper part, and filiform lobes 1 line long. Ovary and style glabrous.

Barbados: Middle School, Christ Church, *Bovell & Freeman 404*, and without precise locality, *Lane 428* (in Herb. Kew), type

INDEX TO AMERICAN BOTANICAL LITERATURE

1907–1921

The aim of this Index is to include all current botanical literature written by Americans, published in America, or based upon American material; the word America being used in the broadest sense.

Reviews, and papers that relate exclusively to forestry, agriculture, horticulture, manufactured products of vegetable origin, or laboratory methods are not included, and no attempt is made to index the literature of bacteriology. An occasional exception is made in favor of some paper appearing in an American periodical which is devoted wholly to botany. Reprints are not mentioned unless they differ from the original in some important particular. If users of the Index will call the attention of the editor to errors or omissions, their kindness will be appreciated.

This Index is reprinted monthly on cards, and furnished in this form to subscribers at the rate of three cents for each card. Selection of cards is not permitted; each subscriber must take all cards published during the term of his subscription. Correspondence relating to the card issue should be addressed to the Treasurer of the Torrey Botanical Club.

Adams, J. F. Rusts of conifers in Pennsylvania. Pennsylvania State Coll. Bull. 160: 3–30. *f. 1–10.* D 1919.

Adams, J. F. Sexual fusions and development of the sexual organs in the peridermiums. Pennsylvania State Coll. Bull. 160: 31–76. *pl. 1–5* + *f. 1–8.* D 1919.

Alexander, W. P. What spring means to the lover of flowers. Hobbies 2^2: 3–9. Je 1921. [Illust.]

Discusses wild flowers near Buffalo, New York.

Allen, R. F. Resistance to stem rust in Kanred wheat. Science II. **53**: 575, 576. 24 Je 1921.

Ashe, W. W. Suggestions for a national arboretum. Jour. For. **19**: 562–564. My 1921.

In a footnote are made many new combinations of *Tsutsusi* (*Azalea*).

Ball, C. R. Undescribed willows of the section *Cordatae*. Bot. Gaz. **71**: 426–437. *f. 1.* 17 Je 1921.

Includes *Salix monochroma* sp. nov. from Wyoming.

Barrus, M. F. Physiological diseases of potatoes. Rep. Quebec Soc. Protect. Plants **9**: 45–53. 1917 [Illust.]

Baxter, S. N. The sassafras. Flor. Exch. **51**: 1469. 25 Je 1921. [Illust.]

A trio of mammoth trees [near Philadelphia] and shoulder formation seldom seen.

Beccari, O. Le palme americane della tribù delle Corypheae. Webbia **2**: 1–343. D 1907.

Includes new species in *Sabal* (5), *Brahea* (2), *Erythea* (1), *Copernicia* (4), *Thrinax* (3), *Coccothrinax* (3).

Becerra, M. E. La "Papaya Orejona" (*Pileus pentaphyllus*). Mem. Soc. Cient. Antonio Alzate **37**: 357–361. *pl. 36.* Ap 1921.

A new species from Mexico.

Benoist, R. Contribution à l'étude de la flore des Guyanes. Bull. Soc. Bot. France **66**: 261–266, 317–328. 4 F 1920; 357–370, 381–398. 7 My 1920.

Includes new species in *Protium* (1), *Sclerolobium* (1), *Inga* (1).

Blake, S. F. The anay, a new edible-fruited relative of the avocado. Jour. Washington Acad. Sci. **9**: 457–462. *f. 1.* 4 O 1919.

Describes 2 new species of *Hufelandia* from Central America.

Blake, S. F. A preliminary revision of the North American and West Indian avocados. Jour. Washington Acad. Sci. **10**: 9–21. *f. 1, 2.* 4 Ja 1920.

Includes 2 new species of *Persea*.

Blake, S. F. Revision of *Ichthyomethia*, a genus of plants used for poisoning fish. Jour. Washington Acad. Sci. **9**: 241–252. 4 My 1919.

Includes 2 new species.

Blake, S. F. The American species of *Maximilianea* (*Cochlospermum*). Jour. Washington Acad. Sci. **11**: 125–132. *f. 1.* 19 Mr 1921.

Includes *M. triphylla* sp. nov. from Venezuela.

Blakeslee, A. F. The Globe mutant in the Jimson Weed (*Datura Stramonium*). Genetics **6**: 241–264. *f. 1.* My 1921.

Boynton, K. R. *Physalis Franchetii.* Addisonia **5**: 57, 58. *pl. 189.* 18 Je 1921.

Boynton, K. R. *Rudbeckia laciniata.* Addisonia **5**: 51, 52. *pl. 186.* 18 Je 1921.

Bradley, C. B. The phyllotaxy of *Phoenix canariensis.* Torreya **21**: 37–44. *pl. 1, 2.* Je 1921.

Brainerd, E. Violets collected at Tyson [Vermont]. Vermont Bot. and Bird Clubs Joint Bull. **7**: 18, 19. Ap 1921.

Britton, N. L., & Rose, J. N. *Neoabbottia*, a new cactus genus from Hispaniola. Smithson. Misc. Coll. **72**[9]: 1–6. *pl. 1–4* + *f. 1, 2.* 15 Je 1921.

Bryce, P. I. A fungus club attacking the oak scale. Rep. Quebec Soc. Protect. Plants **9**: 110, 111. 1917.

Bryce, P. I. Can we improve potato storage methods? Rep. Quebec Soc. Protect. Plants **11**: 53–58. *pl. 8.* 1919.

Burlingham, G. S. Some new species of *Russula*. Mycologia **13**: 129–134. *pl. 7 + f. 1–6.* 25 Je 1921.

Six new species from New England.

Campbell, D. H. The gametophyte and embryo of *Botrychium obliquum*, Mühl. Ann. Bot. **35**: 141–158. *pl. 8 + f. 1–11.* Ap 1921.

Camus, J. S. Rice in the Philippines. Philipp. Bur. Agr. Bull. 37; 1–90. *pl. 1–47.* 1921.

Carpenter, D. S. Botanizing in Essex County [Vermont]. Vermont Bot. and Bird Clubs Joint Bull. **7**: 15–18. Ap 1921.

Choate, H. A. Chemical changes in wheat during germination. Bot. Gaz. **71**: 409–425. *pl. 28 + f. 1, 2.* 17 Je 1921.

Coons, G. H. Cherry leaf spot or yellow leaf. Michigan Agr. Coll. Quart. Bull. 3: 93–96. F 1921. [Illust.]

DeToni, G. B., Forti, A., & Howe, M. A. A new species of *Laurencia* from Chile . . . : *Laurencia chilensis* sp. nov. Nuov. Notar. **32**: 150–153. *f. 1–3.* 1921.

Dickson, B. T. Some plant diseases in the greenhouse. Rep. Quebec Soc. Protect. Plants **11**: 46–48. *pl. 3, 4.* 1919.

DuPorte, E. M. Insect carriers of plant diseases. Rep. Quebec Soc. Protect. Plants **11**: 59–65. 1919.

Durand, E. J. New or noteworthy Geoglossaceae. Mycologia **13**: 184–187. 25 Je

Includes 2 new species of *Trichoglossum*.

Durham, G. B. Growing tomatoes by tip cuttings. Jour. Hered. **12**: 40, 41. 6 Je 1921.

Dutton, D. L. *Aspidium fragrans* on Mount Horrid [Vermont]. Vermont Bot. and Bird Clubs Joint Bull. **7**: 27. Ap 1921.

Eastman, H. & Smith, W. P. Rare plants of Wells River [Vermont] and vicinity. Vermont Bot. and Bird Clubs Joint Bull. **7**: 23. Ap 1921.

Engler, A. Araceae-Aroideae und Araceae-Pistioideae. Pflanzenreich IV. 23 F: 1–274. *f. 1–63.* 6 Jl 1920.

Engler, A. Araceae. Pars generalis et index familiae generalis. Pflanzenreich IV. 23 A: 1–71. 9 Jl 1920.

Eyster, W. H. The linkage relations between the factors for tunicate ear and starchy sugary endosperm in maize. Genetics **6**: 209–240. My 1921.

Fawcett, H. S. Some relations of temperature to growth and infection in the *Citrus* scab fungus *Cladosporium Citri*. Jour. Agr. Research **21**: 243–253. 16 My 1921.

Fawcett, H. S. The temperature relations of growth in certain parasitic fungi. Univ. California Publ. Agric. Sci. **4**: 183–232. *f. 1–11*. 20 My 1921.

Flynn, N. F. Field Meeting of 1920. Vermont Bot. and Bird Clubs Joint Bull. **7**: 9–11. Ap 1921.
Mentions plants seen.

Flynn, N. F. New plants for state [Vermont]. Vermont Bot. and Bird Clubs Joint Bull. **7**: 19. Ap 1921.

Fontanel, G. Facts about weeds and insects. Rep. Quebec Soc. Protect. Plants **9**: 112–117. 1917.

Fontanel, [G.]. La taxonomie et la multiplication des espéces en botanique. Natur. Can. **47**: 174–182; 195–204; 224–234; 244–254. 1921.

Gandoger, M. Sertum plantarum novarum—II. Bull. Soc. Bot. France **66**: 216–233. 11 S 1919; 286–307. 4 F 1920.
Includes new American species in many genera.

Garman, P. The relation of certain greenhouse pests to the transmission of a Geranium leaf spot. Univ. Maryland Agr. Exp. Sta. Bull. 239: 57–80. *f. 1–8*. O 1920.

Harms, H. Neue Arten der Gattungen *Calliandra* und *Pithecolobium*. Repert. Spec. Nov. Regn. Veg. **17**: 87–93. 1 Ap 1921.
Includes new American species in *Calliandra* (10) and *Pithecolobium* (3).

Harter, L. L., & Weimer, J. L. Respiration of sweet potato fungi when grown on a nutrient solution. Jour. Agr. Research **21**: 211–226. *f. 1*. 16 My 1921.

Hartley, C. Damping-off in forest nurseries. U. S. Dept. Agr. Bull. 934: 1–99. *pl. 1 + f. 1–20*. 16 Je 1921.

Hauman, L. Orchidées Argentines. II. Anal. Soc. Cient. Argentina **90**: 95–154. *f. 1–15*. 1920.
Includes new species in *Chloraea* (4), *Asarca* (1), *Stenorrhynchus* (2), *Stenoptera* (1), *Pleurothallis* (1).

Haupt, A. W. Embryogeny and sporogenesis in *Reboulia hemisphaerica*. Bot. Gaz. **71**: 446–453. *pl. 33 + f. 1–8*. 17 Je 1921.

Hoehne, F. C. Leguminosas forrageiras do Brasil. I. *Meibomia* Moehr. (*Desmodium* Desv.) Anex. Mem. Instit. Butantan Bot. **1**[1]: 1–54. *pl. 1–21.* 1921.

Holzinger, J. M., & Frye, T. C. Mosses of the Bureau of Soils Kelp Expedition to Alaska. Publ. Puget Sound Biol. Sta. **3**: 23–64. *pl. 5–8.* 20 My 1921.

Howe, I. A. My botanical work in 1920. Vermont Bot. and Bird Clubs Joint Bull. **7**: 11, 12. Ap 1921.

Huard, V. A. Some problems in botany and entomology. Rep. Quebec Soc. Protect. Plants **11**: 33, 34. 1919.

Janowski, M., & Mez, C. Arundinelleae, in Mez, C., Gramineae novae vel minus cognitae. Repert. Spec. Nov. Regn. Veg. **17**: 84–86. 1 Ap 1921.

Includes ***Arundinella glauca*** **sp. nov., from Mexico.**

Jeffrey, E. C. The geographical distribution of species. Science II. **53**: 556. 17 Je 1921.

Jeffrey, E. C., & Torrey, R. E. Transitional herbaceous Dicotyledons. Ann. Bot. **35**: 227–249. *pl. 11–13 + f. 1–5.* Ap 1921.

Kearney, T. H. Heritable variations in an apparently uniform variety of cotton. Jour. Agr. Research **21**: 227–242. *pl. 48–54 + f. 1.* 16 My 1921.

Kittredge, E. M. Collections in Woodstock [Vermont] in 1920. Vermont Bot. and Bird Clubs Joint Bull. **7**: 24, 25. Ap 1921.

Kittredge, E. M. New plants and new stations. Vermont Bot. and Bird Clubs Joint Bull. **7**: 14. Ap 1921.

Kniep, H. Über *Urocystis Anemones* (Pers.) Winter. Zeitschr. Bot. **13**: 289–311. *pl. 3.* 1921.

Korstian, C. F. Diameter growth in box elder and blue spruce. Bot. Gaz. **71**: 454–461. *f. 1–3.* 17 Je 1921.

Krieger, L. C. C. Common mushrooms of the United States. Nat. Geog. Mag. **37**: 387–439. *pl. 1–16 + 38 figures.* My 1920.

Krout, W. S. Treatment of celery seed for the control of *Septoria* blight. Jour. Agr. Research **21**: 369–372. 1 Je 1921.

Lee, H. A. Black spot of citrus fruits caused by *Phoma citricarpa* McAlpine. Philipp. Jour. Sci. **17**: 635–641. *pl. 1–4.* 20 Ap 1921.

MacDuffie, R. C. Vessels of the gnetalean type in Angiosperms. Bot. Gaz. **71**: 438–445. *pl. 29–32.* 17 Je 1921.

Matz, J. La enfermedad de la raíz en el café. Puerto Rico Dept. Agric. y Trab. Circ. **32**: 1–10. O 1920. [Illust.]

Matz, J. Últimos desarrollos en la patología de la caña de azucar. Puerto Rico Dept. Agric. y Trab. Circ. 33: 32–36. D 1920.

Mazza, A. Aggiunte al saggio di algologia oceanica (Florideae). Nuov. Notar. **32**: 73–132. 1921.

Includes *Fauchea Fryeana* sp. nov., from Washington.

Merrill, E. D. A new genus of Myrsinaceae from the Philippines. Philipp. Jour. Sci. **17**: 605, 606. 20 Ap 1921.

Apoia gen. nov.

Merrill, E. D. Studies on Philippine Rubiaceae, IV. Philipp. Jour. Sci. **17**: 425–485. N 1920.

Murill, W. A. Cacti and their uses. Sci. Am. **124**: 492, 499, 500. 18 Je 1921 [Illust.].

Nash, G. V. *Koelreuteria paniculata.* Addisonia **5**: 61, 62. *pl. 191.* 18 Je 1921.

Nash, G. V. *Pinus Thunbergii.* Addisonia **5**: 55, 56. *pl. 188.* 18 Je 1921.

Nash, G. V. *Pterostyrax hispida.* Addisonia **5**: 59, 60. *pl. 190.* 18 Je 1921.

Nash, G. V. *Rosa* "Edith Cavell." Addisonia **5**: 49. *pl. 185.* 18 Je 1921.

Orla-Jensen, S. The main lines of the natural bacterial system. Jour. Bact. **6**: 263–273. My 1921.

Pammel, L. H. The native white pine of Iowa. Ames For. **9**: 30–32. 1921.

Pennell, F. W. *Penstemon secundiflorus.* Addisonia **5**: 53, 54. *pl. 187.* 18 Je 1921.

Plate is of *P. unilateralis* Rydb., although the text describes *P. secundiflorus* Benth.

Piper, C. V. Some new plants from the Pacific Northwest. Proc. Biol. Soc. Washington **33**: 103–106. 30 D 1920.

Includes new species in *Erysimum* (1), *Arabis* (1), *Castilleja* (2), *Aster* (1), *Achillea* (1), and *Arnica* (3).

Priore, G. L. Il verderame dei tabacchi occidentali. Boll. Tecn. R. Istit. Sci. Sperim. Tabacco **18**: 3–11. Mr 1921.

Rand, F. V., & Cash, L. C. Stewart's disease of corn. Jour. Agr. Research **21**: 263, 264. 16 My 1921.

Ridlon, H. C. A season's botanizing in Bennington [Vermont]. Vermont Bot. and Bird Clubs Joint Bull. **7**: 19–21. Ap 1921.

Rose, J. N. *Epiphyllum Hookeri.* Addisonia **5**: 63, 64. *pl. 192.* 18 Je 1921.

Rusby, H. H. A strange fruit. Torreya **21**: 47–50. Je 1921. [Illust.]

Jarilla Sesseana **(Ramirez) Rusby, of Mexico.**

Schlechter, R. *Basiphyllaea* Schltr., eine verkannte westindische Orchidacee. Repert. Spec. Nov. Regn. Veg. **17**: 76–78. 1 Ap 1921.

Basiphyllaea **gen. nov., from Cuba.**

Schlechter, R., & Hoehne, F. C. Contribuições ao conhecimento des Orquidáceas do Brasil, I. Anex. Mem. Instit. Butantan Bot. **1**[2]: 1–48. *pl. 1–11.* 1921.

Includes new species in ***Habenaria*** (6), *Stelis* (2), *Pleurothallis* (1), *Epidendrum* (1), *Cytopodium* (2), *Maxillaria* (1).

Seifriz, W. Observations on some physical properties of protoplasm by aid of microdissection. Ann. Bot. **35**: 269–296. *1 fig.* Ap 1921.

Setchell, W. A., Goodspeed, T. H., & Clausen, R. E. A preliminary note on the results of crossing certain varieties of *Nicotiana Tabacum.* Proc. Nat. Acad. Sci. **7**: 50–56. 15 F 1921.

Shamel, A. D. Origin of the striped oleander. Jour. Hered. **12**: 42–45. *f. 29–31.* 6 Je 1921.

Shear, C. L., & Dodge, B. O. The life history and identity of "*Patellina Fragariae,*" "*Leptothyrium macrothecium,*" and "*Peziza Oenotherae.*" Mycologia **13**: 135–170. *pl. 8–10* + *f. 1–5.* 25 Je 1921.

Pezizella Lythri **(Desm.) comb. nov.**

Smith, E. F., & Godfrey, G. H. Bacterial wilt of castor bean (*Ricinus communis* L.). Jour. Agr. Research **21**: 255–262. *pl. 55–67* + *f. 1.* 16 My 1921.

Smith, E. F., & McKenney, R. E. B. The present status of the tobacco blue-mold (*Peronospora*) disease in the Georgia-Florida district. U. S. Dept. Agr. Circ. 181: 1–4. 7 Je 1921.

Spegazzini, C. Algunas observaciones relativas a las hojas de Coca (*Erythroxylon Coca* Lam.). Anal. Soc. Cient. Argentina **90**: 23–32. 1920.

Includes new species in *Sphaerella* (1), *Ravenelula* (1), *Protomyces* (1).

Spegazzini, C. Sobre algunas enfermedades y hongos que afectan las plantas de "agrios" en el Paraguay. Anal. Soc. Cient. Argentina **90**: 155–188. 1920. [Illust.]

Includes *Amylirosa, Ephelidium, Pseudohaplosporella, Pseudodiplodia* **gen. nov., and new species in** *Odontia* (1), *Eutypella* (1), *Eutypa* (1), *Cryptosporella* (1), *Ustulina* 1), *Didymella* (1), *Melanomma* (2), *Lophidiopsis* (1), *Amylirosa* (1).

Suessenguth, K. Beiträge zur Frage des systematischen Anschlusses der Monokotylen. Beih. Bot. Centralbl. **38**: 1–79. *f. 1–18.* 15 F 1921.

Sydow, H. & P. Notizen über einige interessante oder wenig bekannte Pilze. Ann. Mycol. **18**: 178–187. Ap 1921.
Includes *Rhizogene* gen. nov.

Taylor, M. A. The figworts [Scrophulariaceae] of Ohio. Ohio Jour. Sci. **21**: 217–239. My 1921.

Tisdale, W. H., & Griffiths, M. A. Flag smut of wheat and its control. U. S. Dept. Agr. Farm. Bull. 1213: 1–6. *f. 1, 2.* My 1921.

Trelease, S. F. The relation of salt proportions and concentrations to the growth of young wheat plants in nutrient solutions containing chloride. Philipp. Jour. Sci. **17**: 527–603. *f. 1–12.* 20 Ap 1921.

Ule, E. Die Vegetation des Amazonasgebietes. Verh. Bot. Ver. Brandenburg **57**: 56–75. *f. 1–4.* 20 Je 1915.

Urban, I. Sertum antillanum, X. Repert. Spec. Nov. Regn. Veg. **17**: 6–11. 1 Ja 1921.
Includes *Penelopeia* gen. nov., and new species in *Exostema* (1), *Guettarda* (1) *Uragoga* (1), and *Eupatorium* (5).

Urban, I. Sertum antillanum, XI. Repert. Spec. Nov. Regn. Veg. **17**: 49–54. 1 Ap 1921.
Includes new species in *Eupatorium* (7), *Aster* (1), *Erigeron* (1), and *Pectis* (2).

Weimer, J. T., & Harter, L. L. Glucose as a source of carbon for certain sweet potato storage-rot fungi. Jour. Agr. Research **21**: 189–210. 16 My 1921.

Weiss, H. B. Diptera and fungi. Proc. Biol. Soc. Washington **34**: 85–88. 30 Je 1921.

Wells, B. W. A method of teaching the evolution of the land plants. Torreya **21**: 45–47. [*with diagram*]. Je 1921

Weston, W. H. The occurrence of wheat downy mildew in the United States. U. S. Dept. Agr. Dept. Circ. 186: 1–6. Je 1921.

Wetmore, A. Wild ducks and duck foods of the Bear River marshes, Utah. U. S. Dept. Agr. Bull. 936: 1–20. *pl. 1–4.* 31 My 1921.
Section on "vegetable foods" gives the abundance of each species.

Winslow, C.-E. A. William Thompson Sedgwick. Jour. Bact. **6**: 255–262. My 1921. [With portrait.]
In his earlier years Professor Sedgwick published some botanical papers.

Young, M. S. The seed plants, ferns, and fern allies of the Austin [Texas] region. Univ. Texas. Bull. 2065: 1–98. 20 N 1920.

Zahn, K. H. Compositae-*Hieracium* [pars]. Pflanzenreich IV. 280: 1–288. *f. 1–27.* 4 F 1921.

Zundel, G. L. Smuts and rusts of northern Utah and southern Idaho. Mycologia **13**: 179–183. 25 Je 1921.

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